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EPITOME

Of the ART of

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EPITOME

OF THE

Art *of* NAVIGATION;

OR, A

Short, Eaſy, and Methodical Way to become a *Compleat Navigator:*

CONTAINING,

Practical Geometry, Plane and Spheric, Superficial and Solid; with its USES in all Kinds of Menſuration.

Trigonometry, Plane and Spheric, both Geometric, Inſtrumental, and Logarithmic; with its USES in NAVIGATION, *viz.*

In *Plane*, *Mercator*'s, and *Great Circle-Sailing*, Geography, Aſtronomy, the Projection of the Sphere, *&c.*

The *Gregorian* or *New* Calendar, Deſcription and Uſe of the *Plane*-Chart, *Mercator*'s-Chart, both Globes, Hemiſpheres, and divers other Inſtruments.

A New Form of keeping a Sea-Reckoning, or Account of a Ship's Way.

A Traverſe-Table; a Table of Meridional Parts; a Table of 10,000 Logarithms, and Logarithmic Sines, Tangents, and Secants, carefully Corrected.

By *JAMES ATKINSON, Senior.*

The Whole reviſ'd, and corrected, with the utmoſt Care, By *W. Mountaine*, Teacher of the *Mathematics*, & F.R.S.

LONDON:
Printed for W. and J. MOUNT, T. PAGE and SON,
on *Tower-Hill.* M,DCC,LIX.

To all LOVERS and LEARNERS
OF
NAVIGATION.

THE *General Approbation* of this *Book*, *ſince its firſt Impreſſion in* 1686, hath obliged me not only to publiſh my *Grateful Acknowledgment* thereof; but alſo excited my diligent Search into, and exact Survey of every Part of its *Structure*, to find out the *Defects*, to know all its *Deficiencies*, which I have ſo far laboured in, That in this Impreſſion

I have now *Rectified* what was amiſs; *Altered* what was Diſorderly; *Explained* what was Dark or Obſcure; *Enlarged* where it was Scanty; *Added* where it was Wanting; And,

Theſe *Rectifications*, *Alterations*, *Emendations*, and *Additions*, being in divers Places, I thought it needleſs to *Enumerate* them particularly; for they are obvious to a diligent *Reader*, that will but compare the *Rules*, *Precepts*, and *Examples* of this with the former *Impreſſions*, in the plain and eaſy Method they are placed in, but which in general is thus;

I. *You have* Practical Geometry, *explained by* Definitions, Problems *and* Proportions; *In this Chapter is taught the making the moſt uſeful* Geometric Figures, *with the meaſuring all* Superficies *and* Solids; *Alſo the* Application *thereof in Practical Meaſuring*, Board, Glaſs, Plaiſtering, Painting, Paving, *and* Land; Timber *and* Stone; Gauging of Caſks, *and a* Ship's Hold: *All being illuſtrated with* Rules, Proportions *and* Examples, *eaſy to the Underſtanding, and not burthenſome to the Memory; and ſo ſtated that they may be performed both by* Arithmetic, *and by the* Line *of* Numbers *on* Gunter'*s-Scale, in* 37 Problems.

The firſt Chapter I adviſe the Learner to ſtudy well before he proceeds, it being preparative to the next, as indeed they are all depending on one another, as Links in a Chain.

II. Plane Trigonometry *is next, in which are many uſeful Notes and Definitions, with the Axioms, and alſo the Caſes depending on each Axiom, orderly ſet down in* 8 Problems, *containing* 13 Caſes.

And here I muſt Advertiſe the Young Student that would work Trigonometry *by the* Logarithms, *to conſult Chapter* 1. The Explanation and General Uſe of the Table of Logarithms, and Tables of Sines, Tangents, and Secants, *towards the latter End of the Book, in* Page 294.

III. *Then follows* Plane Trigonometry, *applied in* Problems *of Sailing by the* Plane Sea-Chart, *commonly called* Plane Sailing.

And that nothing be wanting, I begin with the common Notes of the Julian Calendar *(in this* Edition *tranſmuted for the* Gregorian *or* New Calendar, *as by the late Act of Parliament required) ſhewing how to find the* Prime, Epact, Dominical-Letter, Eaſter Day, the Moon's-Age, Southing, *and Time of* Full-Sea, *or* High-Water, *In* 9 Prob.

Then proceeding to the Deſcription *and* Uſe *of the* Plane-Chart, *in* 5 Problems, *before I come to the* Caſes *of* Plane Sailing, *which I divide into three Parts.*

1. *In a* Right-angled Triangle, *relating to a ſingle Courſe, in which are* 6 Caſes, *commonly called the* 6 Caſes *of* Plane Sailing.

2. *In a* Right-angled Triangle, *relating to ſeveral Courſes called a Traverſe.*

3. *In an* Oblique-Triangle, *in which are but* 4 Caſes, *though there may be a Multitude of various* Queſtions; *of which you have a Taſte in* Turning to Windward, *and* Sailing in Currents, *In* 21 Problems.

IV. *In Chapter* 4th *is* Mercator's Sailing; *To the right underſtanding of which, 'tis neceſſary to deſcribe* Mr. Wright's Projection, *commonly known by the Name of* Mercator's Chart, *and ſhew the Uſes of it, before I treat of the* Problems *of* Sailing *by it; which you will find performed in* *in* 12 Problems: *In the firſt* 9 *the Table of* Meridional Parts, *or the* Meridional-Line *on* Gunter's-Scale *is uſed*; *And in Caſe that Table or Line be wanting, to ſupply their Room, I have added* Problems of Sailing by the Middle Latitude, *which will nearly agree with* Mercator's Sailing, *a Thing of good Uſe, In* 4 Problems.

V. Spheric Trigonometry, *or the Doctrine of* Spheric Triangles Rectangular *and* Oblique, *is next in Order*; *and it being ſo neceſſary you ſhould underſtand how to make a* Spheric Triangle, *and alſo how to meaſure any of its Parts, before the framing and working Proportions therein, I have fully explained that Matter in the beginning of this* Chapter, *being in a Manner a New Invention, which I call* Spheric Geometry; *This you have in* 21 Problems;

And in Spheric Trigonometry *properly ſo called (the next in Order) you have all the* Axioms *and* Caſes, *both in* Rectangular *and* Obliquangular Triangles, *explain'd with neceſſary Notes on each Caſe*; *as to know when a required Angle is* Acute or Obtuſe, *and when a required Side is more or leſs than a* Quadrant, *In* 12 Problems, *containing* 28 Caſes.

VI. The Deſcription and Uſe of both Globes, *is the next to be conſider'd*; *in which I have plainly and familiarly explain'd and ſhewed the Uſe of the moſt neceſſary Things belonging or relating to each of them, In* 24 *uſeful* Problems.

To which is annexed a ſhort Deſcription and Uſe of the Hemiſpheres, *projected on the* Plane of the Ecliptic.

VII. Geography *is the ſubject of this Chapter, which is the Application of* Spheric Trigonometry *in finding the* True Diſtance of Places *in the Variety of their Situation on the* Globe of the Earth, *In* 4 Problems.

VIII. Great Circle Sailing *comes next, which as it's the moſt accurate Way of Sailing, ſo it's the moſt difficult, and hardly poſſible for a Ship exactly to ſail by*; *yet it's of great Advantage to keep conveniently near it: for which Purpoſe you'll find all that neceſſarily belongs or relates to it, both as to the* Projective Part, *and that both* Stereographic *and* Gnomonic; *as alſo in the* Calculate Part, *(which requires the*

the Application of both Spheric *and* Plane Trigonometry,) *fully made out*; *With an Intimation of ſhortning the Work, by ſhewing how to deſcribe the Arc of a* Great Circle *on a* Mercator's Chart; *the Whole in* 4 Problems.

IX. *Next you have* Spheric Trigonometry, *applied in ſundry* Aſtronomic Problems *uſeful in Navigation, wherein the Circles of the* Sphere *are deſcribed, and the neceſſary Terms of Art explained to the meaneſt Capacity, with Reſpect to the diurnal Motion*; *and that either*,

1. *According to the* Ptolomaic Syſtem, *wherein you have in a* Right-Angle Spheric Triangle, *all the Variety of* Queſtions *and* Examples *that relate to the* Sun, *with Reſpect to his Longitude, Declination, Right or Oblique Aſcenſion, or Deſcenſion, Riſing, Setting, Amplitude, Altitude and Azimuth, at the Hour of Six*; *Altitude, and Hour of the Day, when Eaſt or Weſt*; *Hour, Azimuth, and Altitude, when he is in the* Equinoctial, *In* 24 Problems, Alſo,

In an Oblique Spheric Triangle, *you have great Variety both with Reſpect to the* Sun *or a* Star, *in many Queſtions and Examples relating to the* Sun's *Altitude, Azimuth, and Hour of the Day, in any Place, at any Time of the Year*: *And relating to a* Star, *as to its Longitude, Latitude, Declination, Right Aſcenſion, Riſing, Setting, Amplitude, Altitude, Azimuth, Hour of the Night, its Altitude on the Meridian, and Time of its coming to it, In* 12 Problems. *Or*,

2. *According to the* Pythagorean, *or* Copernic Syſtem, *which is now generally receiv'd, as moſt agreeable to the obſerved experienced Motion of the Heavenly Bodies*; *wherein* Spheric Trigonometry *is applied in Variety of Queſtions and Examples relating to the* Earth's Diurnal Motion about its own Axis, *once in* 24 *Hours, whereby all the viſible Appearances of the* Sun *and* Fixed Stars *are ſolved, with the Deſcription of the Circles of the* Sphere, *and how they are drawn* Stereographically *on the* Plane *of the* Earth's Ecliptic, *In* 9 Problems.

X. *Then follow very eaſy Rules to find the* Variation of the Compaſs, *and how to rectify the ſame, and to* Correct the Courſe *thereby, both Arithmetically and Inſtrumentally, with great Readineſs.* *Alſo*,

Alſo here you have the way of Projecting the Sphere Orthographically, *In* 2 Problems, *with many Examples.*

XI. *An Obſervation, either of* Sun *or* Star; *what it is, how or with what, and when 'tis taken; with Rules to find the Latitude of the Place of Obſervation, and all the Varieties therein reduced into one* Propoſition, *containing two* General Caſes, *fully explained by many Examples.*

XII. *You have next the Uſe of all the foregoing Inſtructions, ſummarily comprehended in a new Form of keeping a* Sea Reckoning *or* Journal, *wherein the* Log-Book *and* Journal *in Words at Length, and Tabular in Figures, are kept together in one Book; whereby the whole Proceedings, and every particular Tranſaction of any Voyage at all times may be ſeen and known, which will be no ſmall Satisfaction to thoſe concerned in* Ships *and* Goods, *nor a little Augmentation to the* MARINER's Credit *and* Reputation.

And that ſo uſeful and beneficial a Method may be practiſed by all who deſire to keep a compleat and exact Reckoning, and ſo be enabled to render a good Account thereof, I have largely deſcribed the Form and Manner of it, with plain Rules *and* Directions how to Correct the Reckoning by the obſerved Latitude, *and how to find what* Latitude *and* Longitude the Ship is in every Day; *with an Example of a* Seven Days Journal; *and how each Days ſailing is managed, in taking it from the* Log-Board, *caſting it up, and bringing it into one* Courſe *and* Diſtance; *with framing the* Dead Reckoning, *and transferring it into the* Journal; *ſo that by this the Whole is made more intelligible.*

Laſtly, *In the* Tabular Part, *you have firſt a* Traverſe Table; *which tho' it ſtands in ſo little Room as two Pages, yet by it the* Difference of Latitude and Departure from the Meridian *may be found for any* Diſtance *under* 10,000, *and for every* Quarter Point of the Compaſs.

Next to that, A Table of Meridional Parts *to every* 5 *Minutes of Latitude, which together with the* Table of Proportional Parts *annexed, the Meridional Parts for each ſingle Minute are found.*

And next adjoining is a Table of 10,000 Logarithms.

After which you have a Triangular Cannon Logarithmic, *or a* Table of Artificial Sines, Tangents and Secants, *to every Degree and Minute of the* Quadrant, *which are corrected with more than ordinary Care, there being no Volume (when this* Book *was firſt* publiſhed *in* 1686) *extent that had* Secants *beſides this: The Deſcription and general Uſes of theſe Tables are comprehended in* 4 Chapters, *containing* 13 Propoſitions, *and ſet juſt before the* Tables, *beginning at* Page 294.

The Schemes or Figures are contained in 10 Copper-Plates, *inſerted in their proper Places, being orderly Numbered with proper References for the more eaſy turning unto, upon Occaſion.*

Thus have you a Summary of what's here treated; what my Labour and Pains have been herein, I leave you to judge who are moſt like to reap the Fruit and Profit (my Share being a very ſmall Part thereof) tho' I dare aver, its the Compleateſt and moſt Portable Pile of Inſtructions *(for a* Young Learner of Navigation) *now extant: It's the very Method I have uſed for now* 50 *Years, finding it ever ſucceſsful, even to the moſt indifferent Capacity, among the many Hundreds I have* Taught*: Therefore if my* Reader *would be a* Proficient *herein, let him begin chearfully, proceed gradually, and the end will crown his Endeavours with anſwerable Succeſs.*

Let not Sloth perſuade to give out at the meeting of any Difficulty, but rather remember that Love, Labour *and* Conſtancy will overcome the greateſt Difficulty; *And,*

That my Learner *may ſo read as to underſtand, and ſo underſtand as to be a* Proficient, *is the Deſire of him, who wiſheth the* Young Student's Welfare, *and the* Progreſs *of* ARTS.

JAMES ATKINSON.

EPITOME of the Art of NAVIGATION.

CHAPTER I.

Practical Geometry explained by Definitions, Problems and Proportions.

GEometry is a Mathematic Science, explaining the Kinds and Properties of continued Quantity, or Magnitude; that is, a Line, a Superficies, and a Solid, whoſe Original is from a Punct.

Section I. *Of Lineal Geometry, or the firſt Kind of Magnitude.*

Definitions. 1. A *Punct* or *Point* is that which cannot be divided into Parts, and is the End of a Mathematic Line, as the Punct A. *Plate* 1. *Fig.* 1.

2. A *Mathematical Line* hath no Breadth or Thickneſs, only Length; it is made by the Motion of a Punct, and (conſidered in it ſelf) is either Regular or Irregular.

3. *Regular*, is either a Right-line or an Arc.

4. A *Right-line* is the ſhorteſt Diſtance between two Puncts, as the Line BC. *Plate* 1. *Fig.* 1.

5. An *Arc* is not the ſhorteſt Diſtance between two Puncts, but bendeth evenly, as the Arc DE.

6. *Irregular*, is any crooked Line that bendeth unevenly, as FG. *Plate* 1. *Fig.* 1.

7. *Lines*, compared, are either parallel, or inclining; from whence proceed many Problems.

Problem I. *To draw a Line parallel to a given Line.*

Definition. PArallel Lines are of equal Diſtance, and if infinitely produced (being in the ſame Superficies) will never meet, as the Lines, AB and CD. *Plate* 1. *Fig.* 2.

Example. $\left.\begin{array}{l}\text{AB the Line}\\ \text{C is a Punct}\end{array}\right\}$ given.

Through which Punct C, and parallel to the Line AB, a Line is required to be drawn?

1. Take (with a pair of Compaſſes) the neareſt diſtance between the given Punct C, and the Line AB.

2. With that Diſtance (in the Compaſſes) and one Foot of the Compaſſes (any where in the Line AB,) draw (on that Side the Punct C lieth) an Arc D.

3. From the Punct C, draw a Line to touch the Arc D, and it's done; for the Line CD, is parallel to the Line AB, as was required.

Problem II. *To biſect or divide a given Line into two equal Parts.*

Example. AB is a given Line. *Plate* 1. *Fig.* 3.
To find the middle thereof is required?

1. WITH any Diſtance, (greater than half the given Line AB) and one Foot of the Compaſſes on A deſcribe the Arc CD.

2. With the ſame Diſtance, and one Foot on B, croſs the former Arc in C and D.

3. By C and D draw a Line which will cut AB in E, the middle; and if AE is equal to EB, it's done true: which point E is the middle of the Line AB, as was required.

Prob. III. *To erect a Perpendicular from a Punct in a given Line.*

Definitions. 1. INclining Lines are not of equal Diſtance, and if produced, will meet as the Lines A B and CD. *Plate* 1. *Fig.* 4.

2. The meeting of inclining Lines, (called an Angle) is either Direct or Oblique.

3. *Direct-meeting* of Lines, is when the Angles on each Side are equal, as EGF, and GH; and this kind of meeting is called Perpendicular. *Plate* 1. *Fig.* 4.

Example. AB is a Line given.

The Punct A, one end of it, from whence to erect a Perpendicular is required. *Plate* 1. *Fig.* 5.

1. With any Diſtance, and one Foot in A, draw an Arc to cut the Line AB in D.

2. With the ſame Diſtance, and one Foot in D, draw an Arc, to cut the former Arc in C.

3. With the ſame Diſtance, and one Foot in C, deſcribe an Arc DE, to cut the Line AB in D.

4. By C and D, draw a Line to cut the Arc DE in E.

5. Then by A and E draw a Line, and it's done; For the Line AE is perpendicular unto AB, as was required.

Prob. IV.

Problem IV. *To let fall a Perpendicular, from a given Punct, to a given Line.*

Example. AB is a Line given, C is a given Punct; from whence to let fall a Perpendicular to the Line AB is required? *Plate* 1. *Fig.* 6.

1. Draw a Line (at pleaſure) from C to AB, as is the Line CD.
2. By *Problem* 2. biſect the Line CD in E.
3. With the Diſtance EC, equal to ED, and one Foot in E, croſs the Line AB in A.
4. By A and C draw a Line, and it's done; For AC is a Perpendicular let fall from the Punct C to the Line AB, as was required.

Problem V. *To make a Plane Angle.*

Definitions 1. The meeting of inclining Lines is called an Angle, and the Lines ſo meeting are called Sides of that Angle, as AB and AC. *Plate* 1. *Fig.* 7.

2. An *Angle* is either a Right-Angle, or an Oblique Angle.

3. A *Right-Angle* is where two Lines are perpendicular to each other, as ED and DF. *Plate* 1. *Fig.* 7.

Note, A *Right-Angle* is juſt 90 Degrees.

4. An *Oblique-Angle*, is either Acute leſs than 90 Degrees, as BAC, or Obtuſe more than 90 Degrees, as GHI. *Figure* 7.

Note; An *Angle* is written with three Letters, the middle Letter ſignifieth the Angular Punct, as BAC ſignifieth the Angle A.

An *Angle* is meaſured by an *Arc*, whoſe Center is the angular Punct, and is drawn from one Side to the other of the Angle, as the meaſure of the Angle KLM is the Arc NO. *Plate* 1. *Fig.* 7.

What a Degree is you may ſee in *Problem* 9. *Definition* 1.

Example 1. At A in the Line AB, to make a Right-Angle, *Plate* 1. *Fig.* 7.

The Rule. Upon A (by *Problem* 3.) erect the Perpendicular AC, and it's done; For the Angle BAC is a Right-Angle.

Example 2. At A in the Line AB to make an Acute-Angle equal to 41 Degrees. *Plate* 1. *Fig.* 8.

1. Take (always) a Chord of 60 Degrees from your Scale, and with one Foot on A draw an Arc DE, to cut the Line AB in D.
2. Make the Arc DE, equal to the Chord of 41d. that is, take 41d. from the ſame Scale of Chords, and lay it on the Arc from D to E.
3. By A and E draw the Line AEC, and it's done; for the Angle BAC is an Acute Angle, containing 41 Degrees.

Example 3. At B in the Line BC, to make an Obtuſe-Angle equal to 102 Degrees. *Plate* 1. *Fig.* 8.

1. As before (with one Foot on B) draw the Arc EF with a Chord of 60 deg. to cut BC in E.

2. On that Arc make EG equal to GF, and each equal to 51d. the half of 102d. that is, take 51d. from the ſame Scale of Chords, and lay it on the Arc from E to G, and from G to F.

3. By B and F draw the Line BFD, and it's done; for the Angle CBD is an Obtuſe Angle, containing 102 degrees.

Sect. II. *Of Superficial Geometry, or the ſecond Kind of Magnitude.*

Definitions 1. A Superficies hath no Thickneſs, only Length and Breadth; it's made by the moving of a Line, and is either plane, convex, or concave.

2. A plane Superficies, is a Figure flat, ſmooth, even, and made by the Motion of a Right-line; it's either ſimple or various.

3. A $\left\{\begin{array}{l}\textit{ſimple}\\ \textit{various}\end{array}\right\}$ Figure or Superficies is bounded by $\left\{\begin{array}{l}\text{one Line}\\ \text{Lines.}\end{array}\right.$

4. A *Figure* bounded by one Line, is either a Circle, or an Ellipſis.

5. A *Figure* bounded by Lines, is either a Triangle, a Quadrangle, or a Multangle.

6. In every Superficies there are three things to be noted.

1. The *Term*, which is that Line or Lines bounding it, as BCDEB. *Plate* 1. *Fig.* 9.

2. The *Center*, which is a Punct in the middle of it; as A.

3. The *Area*, which is all the Space contained within the Term, as ABCDEBA. *Plate* 1. *Fig.* 9.

7. The kinds of Plane Figures are ſeven, a *Circle*, a *Triangle*, a *Quadrangle*, and a *Multangle*, the moſt eaſy to make; the more difficult are the *Ellipſis*, *Parabola*, and *Hyperbola*; each affords divers *Problems*, of which we begin with the Circle.

Problem IV. *To deſcribe a Circle, having its Diameter given.*

Definitions 1. A *Circle* is a plane Figure bounded by one Line, called the Periphery; as ABCDEBA. *Plate* 1. *Fig.* 9.

2. The *Periphery* of a Circle is a Line encompaſſing it, ſo that it's equally diſtant from the Center, as BCDEB.

3. The *Center* of a Circle is a Punct in the middle of it, from whence all Right-lines drawn to the Periphery are equal, and call'd Radii, or each, or any one ſuch Line called Radius; as A.

4. The *Diameter of a Circle*, is any Right Line drawn thro' the Center to the Periphery; it biſecteth the Circle, and is the longeſt Right-line that can be drawn in it, as BAD is a Diameter.

Example. BD equal to 60 Inches is given; to make a Circle on or about it, is required? *Plate* 1. *Fig.* 10.

1. Biſect (by *Problem* 2.) the Line BD in A.

2. With the Diſtance AB equal to AD, and one Foot on A, deſcribe the Periphery BCDEB, and it's done.

Problem VII. *To draw the Periphery of a Circle through any three Puncts, not in a Right-line.*

Example. B, C, and D, are three Puncts given, thro' them to draw the Periphery of a Circle is required? *Plate 1. Fig.* 11.

1. With any Diſtance (greater than half CB, or CD) and one Foot in C, draw the Arcs FG, HI.

2. With the ſame Diſtance, and one Foot in B, croſs the firſt Arc in F and G.

3. Likewiſe (with the ſame Diſtance and) one Foot in D, cut the other Arcs in H and I.

4. By F and C, and H and I, draw Lines to cut each other in A the Center.

5. With the Diſtance AB, equal to AC, equal to AD, and one Foot on A, draw the Periphery BCDB, and it's done.

Problem VIII. *To quarter a Circle, or in a Circle to draw two Diameters at Right-angles.*

Example. BCDEB the Periphery, and A the Center of the given Circle; in which to draw two Diameters at Right-angles is required. *Plate* 1. *Fig.* 12.

1. Through the Center A, draw the Diameter BAD.

2. Biſect (by *Problem* 2.) BAD, by drawing the Line CAE, and it's done; and if BC, CD, DE, and EB are equal to each other, it's done true, otherwiſe not.

Problem IX. *To find the Chord, Sine, Tangent, and Secant of an Arc of a Circle.*

Definitions 1. If the Periphery of a Circle be divided into 360 equal Parts, they are Degrees; a Degree divided into 60 equal Parts, are Minutes; a Minute into 60 equal Parts, are Seconds, *&c.* *Plate* 1. *Fig.* 13.

2. The Arc of a Circle is any part of the Periphery; as EB, or EBF; and is counted in Degrees, which are greater or leſs in Proportion to the Radius of the Circle.

3. *Radius* of a Circle is half it's Diameter, or any Right-line drawn from the Center to the Periphery, as AB.

4. A *Chord-line* is drawn from one End of an Arc to the other; as EDF, or EB, are Chord-lines.

5. A *Sine-line* is half a *Chord-line* of double the Arc; as ED (being half the Chord EDF) is a Sine-line of the Arc BE, and DF is a Sine-line of the Arc BF.

6. *Verſed-Sine-line* lies between the Sine-line and the Periphery, as DB is a Verſed-Sine of the Arc BE equal to BF.

7. *Tangent* toucheth the Periphery, and is perpendicular to a Diameter in the touch Punct, as BC is a Tangent Line of the Arc BE.

8. *Secant* cutteth the Periphery, being drawn from the Center 'till it meet the Tangent, as AC is a Secant of the Arc BE.

Example. The Chord, Sine, Tangent, and Secant of an Arc containing 45 deg. are required? *Plate* 1. *Fig.* 13.

1. With any Diſtance (and one Foot on A) deſcribe the Periphery HIBG.

2. Quarter the Periphery (by *Problem* 8.) by drawing the two Diameters HAB and IAG; then is BG equal to GH, equal to HI, equal to IB, equal to 90 degrees.

3. Divide (by *Problem* 2.) BI into two equal Parts in E, and then B E equal to EI, is equal to 45 degrees.

4. Make BF equal to BE, and draw the Lines BE, and EDF, to cut the Diameter HAB in D.

5. At B (by *Problem* 3.) erect BC perpendicular to the Diameter HAB; or draw (by *Problem* 1.) BC parallel to the Diameter IAG.

6. By A and E draw a Line to cut BC in C, and it's done.

Then the Line BE is the Chord of 45 deg. the Line of EDF the Chord of 90 deg. the Line ED equal to DF, the Sine of 45 deg. DB the verſed Sine, BC the Tangent Line, and AC the Secant Line of the ſame Arc BE, equal to 45 deg.

This Problem is the Ground work of the Line of Rhumbs, Chords, Sines, Tangents, Secants, *&c.* Set on Rulers called Scales or plane Scales; As alſo of the Degrees on the Quadrant, Croſs-Staff, and other Mathematic Inſtruments.

But its chief Uſe is in a Right-Angled-Triangle, as ſhall be ſhewed in Trigonometry, when I come to explain the firſt Axiom in making any Side Radius; ſee *Chapter* 2. *Section* 2. in *Page* 36.

Of Triangles, the 2d Kind of Plane Figures.

Definition 1. *A Triangle* is any three corner'd Figure, having three Sides and three Angles, as ABC; and in reſpect of its Angles, is either Rectangular or Obliquangular. *Plate* 1. *Fig.* 14.

2. A *Right-Angle-Triangle* hath one *Right-Angle*; in its making hath a Perpendicular erected, or let fall, as ABC.

3. Thoſe Sides containing the Right-Angle are called Legs: as Leg AB, and Leg BC. *Plate* 1. *Figure* 14.

4. The Side oppoſite to the Right-Angle is called the Hypotenuſe; as AC. *Plate* 1. *Figure* 14.

Prob. X. *To make a Right Angle Triangle, the Hypotenuſe, and one Angle given.*

Note 1. The three Angles of every Plane Triangle (together) are equal to 180 Degrees.

2. To make a Right Angle Triangle, two Things, (beſides the Right Angle) and one a Side, muſt be given.

Example. The { Hypotenuſe AC 137 Feet } given.
{ Angle BAC 34d. 30m. }

With them to make a Right Angle Triangle is required. *Plate* 1. *Fig.* 15.

1. Make the Angle BAC equal to 34d. 30m. (by *Prob.* 5. *Example* 2.) that is, take a Chord of 60d. and with one Foot on A, draw an Arc, and on that Arc, lay the Chord of 34d. 30m. drawing AB and AC, which includes the Angle BAC equal to 34d. 30m.

2. Make AC equal to 137 Feet; that is, from any Scale of equal Parts take 137, and lay it from A to C.

3. From C (by *Prob.* 4.) let fall the Perpendicular BC, to cut the Line AB in B, and it's done.

Prob. XI. *To make a Right Angle Triangle; the Hypotenuſe and one Leg given.*

Example. The { Hypotenuſe AC 411 } Perches given.
{ Leg AB——— 342 }

With them to make a Right Angle Triangle is required. *Plate* 1. *Fig.* 16.

1. Make AB equal to 342 Perches; that is, from any Scale of equal Parts take 342, and lay it from A to B.

2. At B (by *Prob.* 3.) erect a Perpendicular BC.

3. With 411 Perches (That is, take 411 from the ſame Scale of Equal Parts, the 342 was taken) and with one Foot in A, cut the Perpendicular in C.

4. From A to C draw a Line, and it's done.

Prob. XII. *To make a Right Angle Triangle, one Leg and one Angle given.*

Example. The { Leg AB 415 Miles } given.
{ Angle BAC 40d. 25m. }

With them to make a Right Angle Triangle is required. *Plate* 1. *Fig.* 17.

1. Make AB equal to 415 Miles, that is, from any Scale

of equal Parts, take 415, and lay it from A to B; and at B, (by Prob. 3.) in Page 12, erect a Perpendicular BC.

2. At A by Prob. 5. (Example 2.) in page 13, make the Angle B A C equal to 40d. 25m. (which is thus, take a Chord of 60d. and with one Foot on A, draw an Arc, on which Arc lay the Chord of 40d. 25m.) by drawing the Line AC, and it's done.

Problem XIII. *To make a Right Angle Triangle, the Legs given;*

Example. The Leg $\left\{\begin{matrix}\text{AB} & 404\\ \text{BC} & 328\end{matrix}\right\}$ Leagues given.

With them to make a Right Angle Triangle, is required. *Plate* 1. *Fig.* 18.

1. Make AB equal to 404 Leagues; and at B (by Prob. 3.) in Page 12, erect a Perpendicular BC.

2. Upon the Perpendicular make BC equal to 328 Leagues, and from A to C draw a Line, and it's done.

Of Oblique-angle Triangles.

Definition 1. An Oblique Triangle hath three Oblique Angles, and is either an Obtuſe or an Acute Triangle.

2. An Obtuſe Triangle hath one Obtuſe Angle, that is, one Angle more than 90d. as BCD. *Plate* 1. *Fig.* 19.

3. An Acute Triangle hath all its three Angles Acute; that is, each Angle is leſs than 90d. as EFG. *Plate* 1. *Fig.* 19.

Note; To make an Oblique Triangle, three Things, and one of them a Side) muſt be given.

Problem XIV. *To make an Oblique Triangle, two Angles and one Side oppoſite given.*

Example. The $\left\{\begin{array}{l}\text{Angle}\left\{\begin{array}{l}\text{BCD 114d.}\\ \text{BDC 26d. 40m.}\end{array}\right.\\ \text{Side BC 352 Miles}\end{array}\right\}$ given.

With them to make an Oblique Triangle is required. *Plate* 1. *Fig.* 19.

1. Make B C equal to 352 Miles; and at C (by Prob. 5. Example 3.) in Pages 13 and 14, make the Angle BCD equal to 114d. by drawing the Line CD; that is, take a Chord of 60d. and with one Foot on C, draw an Arc, on that Arc lay the Chord of 114d. by taking its half 57d. and laying it twice on the Arc, by which draw the Line CD, thereby you'll conclude the Angle BCD 114 Degrees.

2. As

2. Add 114d. and 26d. 40m. it's 140d. 40m. the Sum of the given Angles; which ſubtract from 180d. 00m. the Sum of the Three Angles.

Remainder is the Angle CBD—— 39d. 20m.

3. At B (by *Prob.* 5. *Example* 2.) in Page 13. make the Angle CBD equal to 39d. 20m. by drawing the Line DB; that is, with a Chord of 60d. and one Foot on B, draw an Arc, on that Arc lay the Chord of 39d. 20m. by which draw the Line BD, and it's done.

Prob. XV. *To make an Oblique Triangle, two Sides and one Angle oppoſite given.*

$$\textit{Example.}\quad \text{The}\left\{\begin{array}{l}\text{Side}\left\{\begin{array}{ll}\text{BC} & 274\\ \text{BD} & 426\end{array}\right\}\text{Miles}\\ \text{Angle}\quad \text{BCD 108d. 30m.}\end{array}\right\}\text{given.}$$

With them to make an Oblique Triangle is required. *Plate* 1. *Fig.* 20.

1. Make BC equal to 274 Miles, and at C (by *Prob.* 5. *Example* 3.) in *Pages* 13 and 14, make the Angle BCD equal to 108d. 30m. by drawing a Line, CD.

2. With 426 Miles, and one Foot in B, cut the Line CD in D, and by B and D, draw a Line, and it's done.

Prob. XVI. *To make an Oblique Triangle, two Sides, and an included Angle given.*

$$\textit{Example.}\quad \text{The}\left\{\begin{array}{l}\text{Side}\left\{\begin{array}{l}\text{BC — 327}\\ \text{BD — 274}\end{array}\right\}\text{Feet}\\ \text{Angle CBD 101d. 30m.}\end{array}\right\}\text{given.}$$

With them to make an Oblique Triangle is required. *Plate* 1. *Fig.* 21.

1. Make the Side BC equal to 327 Feet; and at B (by *Prob.* 5. *Example* 3.) in pages 13 and 14. make the Angle CBD equal to 101d. 30m. by drawing the Line BD.

2. Make BD equal to 274 Feet; and by C and D draw a Line, and it's done.

Problem XVII. *To make an Oblique Triangle, three Sides given.*

Note, Any two Sides muſt be greater than the Third, to make a Triangle.

$$\textit{Example.}\quad \text{The Side}\left\{\begin{array}{ll}\text{BD} & 525\\ \text{BC} & 425\\ \text{CD} & 250\end{array}\right\}\text{Leagues given.}$$

With them to make an Oblique Triangle is required. *Plate* 1. *Fig.* 22.

1. Make BD equal to 525 Leegues; then with 425 Leagues, and one Foot in B draw an Arc C.

2. With 250 Leagues, and one Foot in D, cut the Arc in C, and from C draw Lines to B and D, and it's done.

Sect. III. *Of Proportions for the ready meaſuring of Superficies and Solids.*

HAving ſhewed how to make the moſt common and uſeful Geometric Figures, I now proceed to their (and others) Menſuration, by exact and eaſy Rules.

Now to prevent the Book's ſwelling too great, I will not trouble you with Arithmetic Calculation, but preſent you with an Inſtrumental way of Operation, that's quick and true, eaſy and ready on *Gunter's-Scale*, an Inſtrument ſo very well known, it needs the leſs Deſcription; only to avoid Repetitions take this excellent Rule.

A General Rule for Gunter's-Scale.

Extend the Compaſs from the firſt Term (in a Geometric Proportion) to the ſecond: That Extent (if rightly laid) from the third, will reach to the fourth Term, or Thing required.

This Rule well minded, will make what follows appear eaſy, and ſave many Words and much Time; and therefore to explain it, take this Proportion.

As 2 is to 6; ſo is 5 to 15; which I ſhorten thus;

As 2 .. 6 : : 5 .. 15.

The Extent (on the Line of Numbers) from 2 unto 6, according to the ſaid General Rule) will reach from 5 unto 15, the fourth Term and Thing required.

Theſe Words may be ſpar'd by the ſhort way of writing the Proportion and minding the Order of the Terms, as in the Problems following: But, for a full Explanation of the *Gunter*, and how to work any Proportion by it, ſee my Additions to Mr. WAKELEY's MARINER's COMPASS RECTIFIED, Page 181, &c.

Prob. XVIII. *The Diameter of a Circle given; to find its Periphery.*

The Rule. As $\left\{\begin{matrix}7.\\1.\end{matrix}\right\} .. \left\{\begin{matrix}22\text{———}\\3.14159\end{matrix}\right\} : :$ Diameter .. Periphery.

Example. The Diameter 34 Inches: What's the Periphery? *Anſw.* Inches 106.8 Tenths of an Inch. For,

As $\left\{\begin{matrix}7.\\1.\end{matrix}\right\} .. \left\{\begin{matrix}22\text{———}\\3.14159\end{matrix}\right\} : :$ 34 Inches .. 106.8 Tenths.

That is, the Extent of the Compaſſes (*on the Line of Numbers*) from 7 to 22, or from 1 to 3.14, &c. will reach from 34 Inches to 106.8 neareſt: Obſerve the like in all the reſt.

Prob. XIX. *By the Periphery to find the Diameter.*

The Rule. $$\text{As}\begin{Bmatrix}22\\3.14159\\1.\end{Bmatrix}\cdot\cdot\begin{Bmatrix}7.\\1.\\0.3183\end{Bmatrix}::\text{Periph.}\cdot\cdot\text{Diamet.}$$

Examp. The Periphery Inches 106.8 Tenths; what is the Diameter? *Anſw.* Inches 34. For as 22 .. 7 : : Inches 106.8 .. 34 Inches, the Diameter required.

Prob. XX. *The Diameter of a Circle given; to find its Area, or Content.*

The Rule { 1. Find its Periphery by *Prob.* 18. Then ſay,
2. As 1 .. ½ Diameter : : ½ Periphery .. Area.

Example. The Diameter 14 Inches; What is its Area? *Anſw.* 154 Inches.

By *Prob.* 18. The Diameter being 14, the Periphery is 44 Inches, and by the Rule it is thus.

As 1 .. 7 : : 22 .. 154 Inches, the Area, or Content required?

Prob. XXI. *By the Periphery to find the Area.*

The Rule { 1. Find the Diameter by *Prob.* 19. And then,
2. The Area is found by *Prob.* 20.

Example. The Periphery 22 Inches; What is the Area? *Anſw.* Inches 38.5 Tenths.

The Periphery 22 Inches, the Diameter is 7 Inches, by *Prob.* 19. And by *Prob.* 20, it is thus, As 1 .. 3.5 : : 11 .. Inches 38.5, the Area required.

Note, The Area is of the ſame Name with the Dimenſions taken; That is, if the Diameter, or Periphery be Inches, Feet, or Yards, &c. then the Area is Inches, Feet, or Yards, &c.

Prob. XXII. *To reduce the Area, or Content of any Thing found in Inches, to Feet; or into Beer, or Wine Gallons.*

1. *Rule* for Feet; ſay, 144 .. 1 : : Area in Inch. .. Area in Feet.

2. *Rule* for Gallons. As $\begin{Bmatrix}282\\231\end{Bmatrix}$ .. 1 : : Area in Inch. $\begin{Bmatrix}\text{Beer}\\\text{Wine}\end{Bmatrix}$ Gallons

This needs no Example; and to avoid the firſt Rule, take the Dimenſions in Foot-meaſure; that is, 12 Inches, or a Foot divided Decimally; that is, into 100, 1000, 10000, *&c.* equal Parts, called the Line of *Foot-Meaſure.*

Prob. XXIII. *The Diameter, or Periphery of a Circle given, to find the Side of the inſcrib'd Square, or the Chord of 90 Deg.*

The Rule, As 1 ·· $\left\{\begin{array}{l}\cdot 707\\ .225\end{array}\right\}$: : $\left\{\begin{array}{l}\text{Diamet.}\\ \text{Periph.}\end{array}\right\}$ ·· Side of the inſcribed Square, or Chord or 90d. required.

Example. The Diameter of a Circle being Feet 3.4 Tenths; What is the Side of the inſcribed Square, or the Chord of 90 Degrees? *Anſw.* Feet 2.4038 Parts of 10000.

For; As 1 ·· 0.707 : : 3.4 ·· 2.4038 the Chord of 90 Deg. or Side of the inſcribed Square.

Prob. XXIV. *The Baſe and Perpendicular of a Triangle given; to find the Area.*

The Rule. As 1 ·· $\frac{1}{2}$ Baſe : : Perpendicular ·· Area required.

Example. The Baſe 16 Inches, and the Perpendicular 12 Inches given; I demand the Area? *Anſw.* 96 Inches.

For; As 1 ·· 8 : : 12 ·· 96 the Area required.

Prob. XXV. *The Length and Breadth of a Parallelogram given; to find its Area.*

Definition 1. A Quadrangle hath four Angles, and four Sides, as A B C D; and is either a Parallelogram or a Trapezium, *Plate* 1. *Fig.* 23.

2. A Parallelogram hath its oppoſite Sides parallel and equal, as ABCD; and is either a Square, a Long-ſquare, a Rhombus, or Rhomboide; the firſt two are Rectangled Parallelograms, the latter are Obliquangled Parallelograms.

3. A Square hath four equal Sides, and four equal Angles; as ABCD. *Fig.* 23.

4. A Long-ſquare, hath it's two oppoſite Sides equal, and four equal Angles; as EFGH. *Fig.* 24.

5. A Rhombus, hath four equal Sides, and but two oppoſite Angles equal; as IKLM. *Fig.* 25.

6. A Rhomboide, hath only two oppoſite Sides, and two oppoſite Angles equal: as NOPQ. *Fig.* 26.

Note, The Breadth of the two laſt is not IM nor NQ; but the Perpendicular MN, and QR, and to meaſure all Parallelograms, obſerve this General Rule.

As 1 ·· Breadth : : Length ·· Area required.

Example 1. A Square whoſe Length AB, and Breadth BC, each is Feet 2.5 Tenths; What is the Area? *Anſw.* Feet 6.25 Parts of 100. For; As 1 .. 2.5 : : 2.5 .. 6.25 Area. *Fig.* 23.

Example 2. A Long-ſquare, whoſe Length EH, is Feet 2.5, and Breadth EF is Feet 1.6: What's the Area? *Anſw.* 4 Feet.

For; As 1 .. 1.6 : : 2.5 .. 4 Feet the Area. *Plate* 1. *Fig.* 24.

Example 3. A Rhombus whoſe Length IK is Feet 2.5, and Breadth MN Feet 1.6: What is the Area? *Anſw.* Feet 4.
Plate 1. *Fig.* 25.

For; As 1 .. 1.6 : : 2.5 .. 4 Feet the Area required.

Example 3. A Rhomboide whoſe Length NO, is Feet 25, and Breadth QR Feet 12. What is its Area? *Anſw.* 300.

For; As 1 .. 12 : : 25 .. 300 Feet the Area required.
Plate 1. *Fig.* 26.

Prob. XXVI. *The Diagonal and two Perpendiculars of a Trapezium given; to find its Area.*

Definition 1. A *Trapezium* hath its oppoſite Sides, and its oppoſite Angles unequal; as ABCD. *Plate* 1. *Fig.* 27.

2. The *Diagonal*, is a Line drawn from its oppoſite Angles; as AC.

3. The two Perpendiculars, are let fall from the Angles to the Diagonal; as BE, and DF.

The Area of a Trapezium, is found by this Rule.

As 1 .. ½ Diagonal : : Sum of the Perpendiculars .. Area req.

Example. The Diagonal AC 28 Feet: The Perpendicular BE 15 Feet; and DF 12 Feet? What's the Area? *Anſw.* 378 Feet.

For; As 1 .. 14 : : 27 .. 378 Feet the Area required.
Plate 1. *Fig.* 27.

Prob. XXVII. *The Length and Breadth of an Ellipſis called an Oval, given; to find the Area.*

The Rule. As 1 .. Breadth .. Length .. 4th Numb. Then ſay again.

As $\left\{\begin{matrix}14\\1\end{matrix}\right\} \cdot\cdot \left\{\begin{matrix}11 \text{——}\\ .78539\end{matrix}\right\}$: : 4th Number .. Area required.

Example. The Tranſverſe Diameter of an Ellipſis 12 Feet, and Conjugate Diameter 8 Feet. What's the Area? *Anſw.* Feet, $75\frac{4}{10}$.

For, As 1 .. 8 : : 12 .. 96 the Fourth Number.

Then, As 14 .. 11 : : 96 .. Feet 75.4 the Area required.

Prob. XXVIII. *To find the Area of a Parabola.*

The Rule. As 1 .. Axe : : Double Ordinate .. 4th Number.
Then, ſay again, As 3 .. 2 : : 4th Number .. Area required.

Examp. The Axe of a Parabola 9 Feet, and the Double Ordinate 8 Feet. What's the Area? *Anſw.* 48 Feet.

For ; — As 1 .. 9 : : 8 .. 72 the 4th Number.
And then ; — As 3 .. 2 : : 72 .. 48 Feet the Area required.

Sect. IV. *Of Solids, the third Kind of Magnitude.*

Definition. A *Solid* hath Length, Breadth and Depth ; and is bounded by one Superficies, is either a Sphere, or a Spheriod ; but bounded by more than one Superficies, is either a Priſm, a Pyramid, a Priſmoid, or a Pyramidoid ; or compounded of the laſt, called a Spindle.

Prob. XXIX. *The Diameter of a Sphere given ; to find the Solid Content.*

Definition. A *Sphere* or *Globe*, is a Round Solid, whoſe Length, Breadth, and Depth, are a-like and equal ; being made by the Rotation, or moving of a Semi-circle about its Diameter ; whoſe Solid Content is found by this Rule.

$$\text{As}\left\{\begin{matrix}21\\1\end{matrix}\right\}\,..\,\left\{\begin{matrix}11\text{——}\\ .523599\end{matrix}\right\}::\text{Cube of Diam.}\,..\,\text{Cont. required.}$$

Example. A *Sphere* whoſe Diameter is Feet 2.42 Parts : What's the Solid Content ? *Anſw.* Feet 7.43 Parts of 100.

For ; — As 1 .. 2.42 : : 2.42 .. 5.86 : : 5.86 .. 14.17 the Cube of the Diameter ; Then, Feet

$$\text{As}\left\{\begin{matrix}21\\1\end{matrix}\right\}\,..\,\left\{\begin{matrix}11\text{ —}\\ 0.524\end{matrix}\right\}::14.17\,..\,7.43\text{ the Content required.}$$

In ſuch Caſes as this, the readieſt Way is to extend the Compaſſes from the firſt Term to the third Term ; and that being turned over three times from the ſecond Term, will reach the Thing required.

As here, the Extent from 1 to Feet 2.42, the Diameter, turned three times from 0.524, *&c.* reacheth to Feet 7.43 Parts of 100, the Content required. For it's thus ;

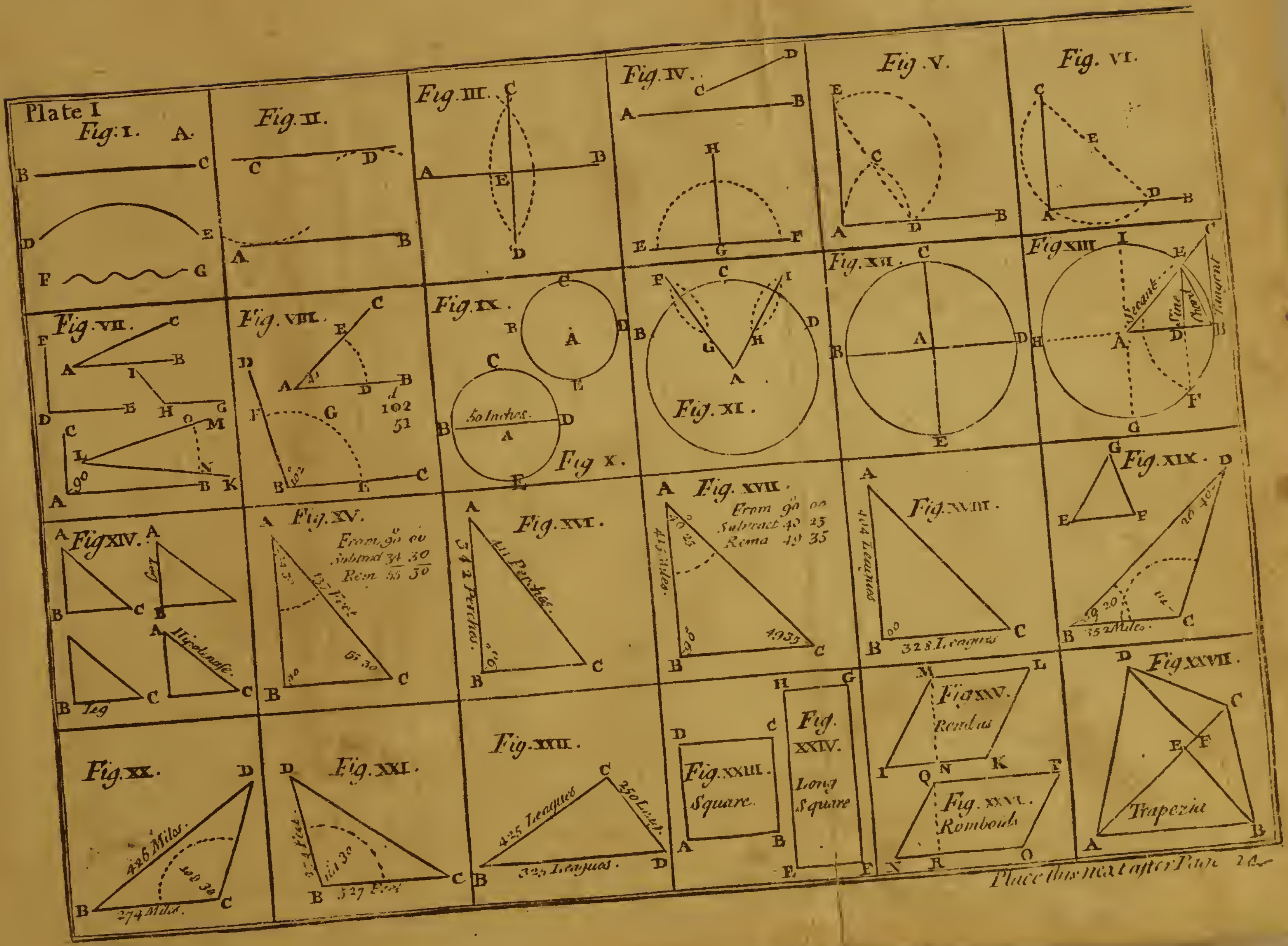
1 .. 2.42 : : 0.524 .. 1.27 : : 1.27 .. 3.07 : : 3.07 .. 7.43, that is, The Extent from 1 to 2.22, (on the Line of Numbers) will reach from 0.524 to 1.47 ; and the ſame Extent will reach from 1.27 to 3.07 ; and the ſame Extent from 3.07 reacheth to Feet 7.43 Parts of 100.

Prob. XXX. *The Diameters of a Spheroid given ; to find the Solid Content.*

Definition. A *Spheroid* is an Oval Solid, Longer than it is Broad or Deep ; being made by the Rotation of a Semi-Ellipſis about its Diameter ; the Solid Content is found by this Rule.

Rule.

Plate I



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Rule. As 1 .. Square of Depth : : Length .. a 4th Num. then ſay,

$$\text{As}\left\{\begin{matrix}21\\1\end{matrix}\right\}\,..\left\{\begin{matrix}11.\\.524\end{matrix}\right\}::\text{ 4th Number .. Content required.}$$

Example. *A Spheroid,* whoſe

$$\left.\begin{matrix}\text{Length or Tranſverſe}\\\text{Depth or Conjugate}\end{matrix}\right\}\text{ Diameter is Inches }\left\{\begin{matrix}7.2\\4.1\end{matrix}\right\}\text{Tenths.}$$

What's the Solid Content? *Anſw.* Inches 63.4 Tenths.

For it's, As 1 .. Square 4.1 : : 7.2 .. 121; here the Extent from 1 to 4.1 is turned twice from 7.2, and it reacheth to 121. Then ſay,

$$\text{As}\left\{\begin{matrix}21\\1\end{matrix}\right\}\,..\,121::\left\{\begin{matrix}11.\\.524\end{matrix}\right\}..\left\{\begin{matrix}\text{Inches 63.4 Tenths, the}\\\text{Content required.}\end{matrix}\right.$$

Or thus; As 1 .. 4.1 : : 0524 .. 2.15 : : 2.15 .. 8.81;

That is, the Extent on the Line of Numbers from 1 to 4.1 will reach from 0.524 to 2.15; and the ſame Extent from 2.15 to 8.81 Parts of 100.

Then; As 1 .. 8.81 : : 7.2 .. 63.4; that is, the Extent from 1 to 8.81, will reach from 7.2 to Inches 63.4 Tenths, the Solid Content required.

Prob. XXXI. *The Dimenſions of a Priſm given; to find the Solid Content.*

Definition 1. A *Priſm*, is a ſtrait Solid, whoſe two Baſes or Ends, are equal, parallel, a-like, and a-like ſituate.

2. A *Priſm*, takes its Sir-Name from its Baſe; as a Round Priſm, a Triangular, a Quadrangular, or a Multangular Priſm, all are meaſured by this one General Rule.

As 1 .. Area of one Baſe : : Length .. Solid Content.

Example 1. A Round Priſm, called by ſome a Cylinder, whoſe

$$\left.\begin{matrix}\text{Diameter at each End is ——— }21\\\text{And Length is ——————— }30\end{matrix}\right\}\text{Inches.}$$

What's the Solid Content? *Anſw.* 10392 Inches.

A Cylinder's two Baſes are two equal Circles, and therefore the Area of its Baſe is found by *Prob.* 30. to be Inches 346.4 Tenths; Then it is,

As 1 .. 346.4 : : 30 .. 10392 Inches, the Solid Content req.

Example 2. An Elliptic Priſm, whoſe Baſes are equal Ellipſis's, their

$$\left.\begin{matrix}\text{Tranſverſe}\\\text{Conjugate}\end{matrix}\right\}\text{ Diameter is }\left\{\begin{matrix}12.\\8.\end{matrix}\right\}\text{ Inches given.}$$

Length of the Solid is —— 30.

What's the Solid Content? *Anſw.* Inches 2262.

For its Baſe being an Ellipſis, the Area by *Prob.* 27 is Inches 75.4, and then it is,

As 1 ·· 75.4 : : 30 ·· 2262 Inches the Solid Content required.

Example 3. A Triangular Priſm, whoſe Baſes are two equal Triangles, in each of which

$$\text{The}\left\{\begin{array}{l}\text{Baſe ————}\\ \text{Perpendicular}\end{array}\right\}\text{is}\left\{\begin{array}{l}16.\\ 12.\end{array}\right\}\text{Inches given.}$$

And the Length of the Solid is 20 Inches.

What's the Solid Content? *Anſw,* Inches 1920.

The Area of the Baſe (by *Prob.* 24) in Page 22, is 96 Inches; and then it's,

As 1 ·· 96 : : 20 ·· 1920 Inches, Solid Content required.

Example 4. A Cube which is a Quadrangular Priſm, of equal Length, Breadth and Depth, being cloathed with ſix equal Squares, each Side being Inches 12: What's the Solid Content? *Anſw.* Inches 1728.

For, As 1 ·· Square of 12 : : 12 ·· 1728: That is, the Extent from 1 to 12, turned over two Times from 12, reacheth to Inches 1728 the Solid Content required.

Example 5. A Parallelopipedon, or Quadrangular Priſm, whoſe Baſes are two equal Squares, of each, one

$$\left.\begin{array}{l}\text{Side}\\ \text{Length}\end{array}\right\}\text{is Feet}\left\{\begin{array}{r}1.25\\ 21.75\end{array}\right\}\text{Parts of 100 given;}$$

What's the Solid Content? *Anſw.* Feet 33.9 Tenths.

For, As 1 ·· Square of 1.25 : : 21.75 : : Feet 33.9 :. That is, the Extent from 1 to 1.25, being turned two Times from 21.75 will reach to 33.9, the Solid Content required.

Example 6. A Parallelopipedon, or a Quadrangular Priſm, whoſe Baſes are two equal Long-ſquares, in each,

$$\left.\begin{array}{l}\text{The}\left\{\begin{array}{l}\text{Breadth is ———— 1.6}\\ \text{Depth is ———— 2.5}\end{array}\right.\\ \text{And Length of the Solid—15.5}\end{array}\right\}\text{Feet given.}$$

What's the Solid Content? *Anſwer* Feet 62.

For it is, As, 1 ·· 1.6 : : 2.5 ·· 4 Feet, the Area of the Baſe.

Then, As 1 ·· 4 : : 15.5 ·· 62 Feet, Solid Content req.

In the like manner may be the Solid Content of any Priſm be found, let its Baſe be of what Form ſoever; for its Area may be found by *Prob.* 20, 21, 22, 23, 24, 25, 26, or 27, and the Solid Content of the Priſm, by the General Rule in *Problem* the 31ſt.

Prob. XXXII. *The Dimenſions of a Pyramid given; to find the Solid Content.*

Definition 1. A *Pyramid* is a ſtrait Solid, having one Baſe, and t'other End a Punct, called the Vertex.

2. A *Pyramid*, takes its Sir-name from its Baſs, as a Round, an Elliptic, a Triangular, a Quadrangular, or a Multangular Pyramid; all are meaſured by this one General Rule.

As 3 ·· Area of Baſe : : Length ·· Solid Content.

Note; By Length underſtand a Perpendiculr from the Vertex to the Baie, and not the Length of the Pyramid on its Surface or outſide from Vertex to Baſe.

Example. A Round Pyramid, called by ſome a Cone, whoſe

Diameter at Baſe ——— 21 } Inches given.
Perpendicular Length — 30 }

What's the Solid Content? *Anſw.* 3465 Inches.

For the Area of the Baſe is Inches $346\frac{5}{10}$ by *Prob.* 20. And, Then; As 3 ·· 346.5 : : 30 ·· 3465 Inches, whtch is the Solid Content required.

The like do for any other Pyramid, which I paſs over, having given ſix Examples in a Priſm, and leave you to apply them here.

Prob. XXXIII. *The Dimenſions of a Priſmoid given; to find the Solid Content.*

Definition 1. A *Priſmoid*, is a ſtrait Solid having two unequal Baſes or Ends, but are parallel, like, and a-like ſituate.

2. A *Priſmoid*, is as various as a Priſm, and is no other than the Fruſtrum of a Pyramid.

3. *Fruſtum of a Pyramid*, is the lower Part of it, when the upper Part of it is cut off parallel to the Baſe; and all of them may be meaſured by this General Rule.

1. Multiply the Area of each Baſe together, and from the Product extract the Square Root.

2. Add the Area of each Baſe and that Square Root into one Sum: Then,

3. Say, as 3 ·· that Sum : : Length ·· Solid Content.

But for a *Square Priſmoid*, take this particnlar Rule;

1. To the Square of each Side, add the Product of the Sides into one Sum; then,

Say, As 3 ·· that Sum : : Length ·· Solid Content.

And for a *Round Priſmoid* this is the Rule.

1. Add the Square of each Diameter and the Product of the two Diameters into one Sum: And then,

2. Say, As 3.82 .. that Sum : : Length .. Solid Content.

Or more largely thus, As 3.8197, is to the aforeſaid Sum; ſo is the Length, to the Solid Content.

Example 1. *A Square Priſmoid, (or the Fruſtum of a Square Pyramid) whoſe*

$$\begin{array}{l}\left.\begin{array}{l}\text{Greateſt}\\ \text{Leaſt}\end{array}\right\}\text{Side is Inches.}\\ \text{Perpendicular Length}\end{array}\left\{\begin{array}{r}15\\ 9\\ 60\end{array}\right\}\text{Inches given;}$$

What's the Solid Content? *Anſw.* 8820 Inches.

$$\text{For; As } 1 \ .. \left\{\begin{array}{c}15\\ 9\\ 9\end{array}\right\} : : \left\{\begin{array}{c}15\\ 9\\ 15\end{array}\right\} .. \left\{\begin{array}{r}225 \text{ Square.}\\ 81 \text{ Square.}\\ 135 \text{ Product.}\end{array}\right.$$

Sum of the two Squares and Product is — 441 Inches;

Then, As 3 .. 441 : : 60 .. 8820 Inches, the Solid Content required?

Example 2. *A Round Priſmoid (or the Fruſtum of a Cone) whoſe*

$$\begin{array}{l}\left.\begin{array}{l}\text{Greateſt}\\ \text{Leaſt}\end{array}\right\}\text{Diameter is}\\ \text{Perpendicular Length is}\end{array}\left\{\begin{array}{r}1.5\\ 0.9\\ 60.0\end{array}\right\}\text{Feet given.}$$

What's the Solid Content? *Anſw.* Feet 69.25.

$$\text{For; As } 1 \ .. \left\{\begin{array}{c}1.5\\ 0.9\\ 0.9\end{array}\right\} : : \left\{\begin{array}{c}1.5\\ 0.9\\ 1.5\end{array}\right\} .. \left\{\begin{array}{l}2.25 \text{ Square.}\\ 0.81 \text{ Square.}\\ 1.35 \text{ Product.}\end{array}\right.$$

Sum of the two Squares and Product — 4.41 Feet.

Then, As 3.82 .. 4.41 : : 60 .. 69.25 Feet, the Solid Content.

Example 3. *An Elliptic Priſmoid or the Fruſtum of an Elliptic Cone, whoſe*

$$\left.\begin{array}{lr}\text{Greateſt Diameter at Top, Inches} & 7.5\\ \text{Leaſt Diameter at Top ———} & 5.\\ \text{Greateſt Diameter at Bottom ——} & 8.7\\ \text{Leaſt Diameter at Bottom ———} & 5.8.\\ \text{Perpendicular Length —— Inches} & 47.0\end{array}\right\}\text{Tenths given.}$$

What's the Solid Content? *Anſw.* 1617.4 Inches. For,

$$\text{As } 1 \;..\; \left\{\begin{matrix}5.\\5.8\end{matrix}\right\} :: \left\{\begin{matrix}7.5\\8.7\end{matrix}\right\} \;..\; \left\{\begin{matrix}\text{37.5 Area of Top Long Square.}\\\text{50.46 Area of Bottom Ditto.}\end{matrix}\right.$$

As 1 .. 37.5 :: 50.46 .. 1892.25 whoſe Square Root is 43.5
Area at Top ——— 37.5
Area at Bottom —— 50.46

Sum is — 131.46

Then; As 3.82 .. 131.46 :: 47 .. 1617.4 Inches the Solid Content required.

If the Baſes of the aforeſaid Priſmoid had been long Squares the Work is the ſame, except only in the laſt Proportion; and having the ſame Dimenſions, it's Solid Content is Inches 2060, very near, for it is thus,

As 3 .. 131.46 :: 47 .. 2059.5 Inches the Solid Content.

Prob. XXXIV. *The Dimenſions of a Pyramidoid given; to find its Solid Content.*

Definition 1. A *Pyramidoid* is not a ſtrait Solid, it hath one Baſe, and t'other End a Punct called the Vertex, but the outſide from Baſe to Vertex, is convex, either Spheroidic, Parabolic, or Hyperbolic, *&c.*

2. A Pyramidoid, takes its Sir-name from its Baſe and outſide; as a Spheroidic, Parabolic, or Hyperbolic Round Pyramidoid; and ſo of the reſt, as in a Pyramid; all may be meaſured by this one General Rule;

As 1.5 .. Area of the Baſe :: Length .. Solid Content, when a Spheroidic Pyramidoid; but if

$$\left.\begin{matrix}\text{Pyrabolic}\\\text{Hyperbolic}\end{matrix}\right\}\text{The firſt Term is}\left\{\begin{matrix}2.\\2.4\end{matrix}\right.$$

Example. A Round Pyramidoid, called by ſome a Conoid, whoſe

$$\left.\begin{matrix}\text{Diameter at the Baſe ——— 21}\\\text{Perpendicular Length ——— 30}\end{matrix}\right\}\text{Inches.}$$

$$\text{What's the Solid Content, if}\left\{\begin{matrix}\text{Spheroidic?}\\\text{Parabolic?}\\\text{Hyperbolic?}\end{matrix}\right\}\textit{Anſw.}\left\{\begin{matrix}6930\\5197.5\\4331.2\end{matrix}\right.$$

The Area of the Baſe is Inches 146.5. Tenths, by *Prob.* 20. And then it's,

$$\text{As}\left\{\begin{matrix}1.5\\2.\\2.4\end{matrix}\right\} \;..\; 146.5 :: 30 \;..\; \left\{\begin{matrix}\text{6930 Spheroidic}\\\text{5197.5 Parabolic}\\\text{4331.2 Hyperbolic}\end{matrix}\right\}\begin{matrix}\text{Solid}\\\text{Cont. in}\\\text{Inches.}\end{matrix}$$

More Examples I think here needleſs, having given ſo many in a Priſm, and the Rule for this and that being ſo much alike.

Prob. XXXV. *The Dimenſions of a Fruſtum of a Parabolic Pyramidoid given; to find the Solid Content.*

Definition. *Fruſtum*, is the lower Part of a Pyramidoid, cut parallel to its Baſe.

A General Rule.

This is the ſame with the General Rule for a Priſmoid, ſave only in the third Precept, which in this Caſe is thus,

As 2 .. that Sum : : Length .. Solid Content required.

But for the Fruſtum of a Square Parabolic Pyramidoid take this particular Rule.

1. To the Square of the greateſt Side, add the Square of the leaſt Side into one Sum: Then,

2. Say, As 2 .. that Sum : : Length .. Solid Content required.

And for a Round Fruſtum, that is Parabolic, the Rule is;

1. Add the Square of each Diameter into one Sum; Then,

2. Say, As 2.546 .. that Sum : : Length .. Solid Content.

Or more largely thus; As 2.54649, is to the foreſaid Sum; ſo is the Length to the Solid Content.

Example 1. The Fruſtum of a Square Parabolic Pyramidoid, whoſe

$$\left.\begin{array}{l}\text{Side at Top ———}\\ \text{Side at Bottom ———}\\ \text{Perpendicular Length—}\end{array}\right\}\text{ is Inches }\left\{\begin{array}{c}4\\6\\48\end{array}\right\}\text{ given;}$$

What's the Solid Content? *Anſw.* 1824 Inches.

For; As 1 .. 4 : : 4 .. 16 the Square at Top.
As 1 .. 6 : : 6 .. 36 the Square at Bottom.
As 1 .. 4 : : 6 .. 24 the Product of the two Sides.

Sum of the two Squares 76 Inches, and the Product of the two Sides.

Then ſay; As 2 .. 76 : : 48 .. 1824 Inches, the Solid Content.

Example 2. The Fruſtum of a Round Parabolic Pyromidoid, (or the Fruſtum of a Parabolic Conoid) whoſe

$$\left.\begin{array}{ll}\text{Diameter at Top ————} & 4\\ \text{Diameter at Bottom ————} & 6\\ \text{Perpendicular Length ————} & 48\end{array}\right\}\text{ Inches given.}$$

What's its Solid Content? *Anſw.* 1433 Inches.

For; As 1 ·· 4 : : 4 ·· 16 the Square at Top.
As 1 ·· 6 : : 6 ·· 36 the Square at Bottom.
As 1 ·· 4 : : 6 ·· 24 the Product of both Diameters.

Sum of the two Squares — 76 Inch. & the Product of both Diam.
Then ſay; As 2.546 ·· 76 : : 48 ·· 1433 Inches, the Solid Content.

Sect. V. *The Application of the whole, in meaſuring Board, Glaſs, Plaiſtering, Painting, Paving, and Land, Timber and Stone, Gauging of Caſk, and a Ship's Hold.*

1. BOard or Plank, Glaſs, and flat Stone, are meaſured by the Foot Square, or Superficial Foot, containing 144 Square Inches, or 12 Times 12; ſo that to know how many Square Feet are contained in the Area, or Content of any Superficies taken in Inches, the Proportion is this:

As 144 ·· 1 : : Content in Inches ·· Content in Feet.

But the eaſieſt Way, is to have the Foot of 12 Inches divided Decimally into 100 Parts, called Foot Meaſure; and by ſuch a Foot, to take the Dimenſions of the Thing you would meaſure, or know the Content of, in Feet.

Then conſider, if the Thing to be meaſured be a Circle, Triangle, Square, Long-ſquare, *&c.* the Rule proper for ſuch a Figure (in *Sect.* 3. of this *Chapter*) directs to find the Area, That is,

If the Thing to be meaſured be a Circle, then *Prob.* 20. or 21 ſheweth how to find its Area; if it's a Triangle, then *Prob.* 24 gives a Rule to find the Area; if a Parallelogram *Prob.* 25 hath a Rule to find its Area, whether it be a Square, a Long-ſquare, a Rhombus, or Rhomboide; now Floors and Ceilings of Houſes are generally Squares, or Long-ſquares; alſo Boards, Planks and flat Stones, are (commonly) Squares or Long-ſquares; If a Trapezium, then *Prob.* 26. ſheweth how to meaſure it; if it be an Ellipſis, *Prob.* 27. hath a Rule for its meaſuring, and ſuch are oval Tables; and if the Thing to be meaſured be a Parabola, then *Prob.* 28. ſheweth how to find its Area.

2. *Plaiſtering*, *Painting*, and *Paving*, is meaſured by the Yard Square, containing nine Square Feet; and therefore after you have found the Content in Feet; the Proportion is this,

As 9 ·· 1 : : Content in Feet ·· the Content in Yards.

3. Timber is meaſured by the Cubic Foot, containing 1728

Solid Inches; And when the Content of any Solid Body is known in Cubic Inches, to reduce them into Cubic Feet, which is the Timber, or Stone Foot, the Proportion is this,

As 1728 .. 1 : : Cubic Inches .. Solid Feet.

But meaſuring the Dimenſions of a Solid, by the aforeſaid Decimal Foot, the Rules proper for it (in *Sect.* 3. of this *Chap.*) as a Sphere, Priſm, *&c.* Finds the Solid Content in Feet.

That is, if it be a Sphere, then *Prob.* 29. hath a Rule to find its Solid Content, ſuch are Bullets, and Granadoes uſed in great Guns, Mortars or Bombs.

If a Spheriod, then *Prob.* 30 ſheweth the meaſuring of it, and ſuch are Things in Shape like an Egg, whoſe Ends are equal.

If a Priſm, then *Prob.* 31 directs its Meaſurement, and by this all ſtrait Pieces of Timber or Stone, whoſe Ends are alike and equal, are meaſured.

If a Pyramid, then *Prob.* 32 ſhews the meaſuring it, and ſuch are Spire Steeples, and all ſtrait Solids ending in a Point at one End.

If a Priſmoid, then *Prob.* 33 ſheweth its meaſuring, and ſuch is all Taper Timber, whether Round or Square.

If a Pyramidoid, then *Prob.* 34 ſheweth the meaſuring of it, and ſuch is the Half of all Caſks, if they were continued from the Bung by the Head, till they end in a Point.

If a Fruſtum of a Parabolic Pyramidiod, then *Prob.* 35 ſerves to meaſure it, and ſuch are cloſe Caſks, if cut in Halves through the Bung, and parallel to each Head; ſo that by this Problem is taught the Way of finding the half Content of a Caſk, whoſe Double is the whole Solid Content: But a more particular Rule for Gauging a Caſk, followeth in the next Problem.

4. Land is meaſured by the Rod or Pole, containeth in Length Feet 16 $\frac{1}{2}$, and a Square Rod is Feet 272 $\frac{1}{4}$, an Acre of Land containing 160 Square Rods.

Now the readieſt Way to caſt up the Content of Land in Acres, is to take the Dimenſions by a four Pole Chain, Decimally divided (that is, into 100 Links) then the Rule (in *Sect.* 3. of this Chap.) proper to the Form of it, (whether a Triangle, Square, Long-ſquare, Rhombus, Rhomboide, or Trapezium,) finds the Content in Square Chains, which are turned to Acres thus;

As 10 .. 1 : : Square Chains .. Content in Acres.

5. *Gauging* is by the Gallon, and that either Beer, containing 282 Cubic Inches, or Wine 231 : Then to reduce Cubic Inches into Gallons of either Kind, the Rule is ;

$$\text{As}\left\{\begin{matrix}282\\231\end{matrix}\right\}\ldots 1 :: \text{Cubic Inches} \cdot\cdot\ \text{Gallons of}\left\{\begin{matrix}\text{Beer.}\\\text{Wine.}\end{matrix}\right.$$

So that the Dimenſions of any Solid Body taken in Inches, the proper Rule for that Body, finds its Content in Inches, and the Rule above finds the Gallons of Beer, or Wine it will hold.

Prob. XXXVI. 6. *To Gauge a Caſk, taken as the middle Fruſtum of a Spheroid.*

The Rule. 1. Add twice the Square of the Bung-Diameter, and once the Square of the Head, into one Sum. Then ſay,

2. As 3.82 ·· that Sum : : Length ·· Solid Content of the Caſk in Inches ; and then the Gallons of Beer, or Wine, are found by the foregoing Rule. Or thus,

1. Say, As 1 ·· 0.7 : : Difference of Head and Bung ·· a Fourth Number.

2. That 4th Number add to the Head Diameter, the Sum is a Mean Diameter : Then ſay,

$$\text{As}\left\{\begin{matrix}18.95\\17.15\end{matrix}\right\}\cdot\cdot\ \text{Sq. Mean Diam.} :: \text{Length} \cdot\cdot \left\{\begin{matrix}\text{Beer}\\\text{Wine}\end{matrix}\right\}\text{Gallons}$$

Exam. A Caſk whoſe Bung Diameter is 23.

$$\left.\begin{matrix}\text{Head Diameter} \text{ ——————— } 19.9\\\text{Length of the Caſk} \text{ ——————— } 27.4\end{matrix}\right\}\text{Inches given.}$$

What's the Content thereof in Beer, or Wine Gallons?

Anſw. Beer Gallons 36.99, or Wine Gallons 45.5.

As 1 .. 0.7 : : 3.1 .. 2.17, which added to 19.9 ; makes the Mean Diameter to be 22.07. Then,

$$\text{As}\left\{\begin{matrix}18.95\\17.15\end{matrix}\right\}\ldots \text{Square } 22.07 :: 27.4 \cdot\cdot \left\{\begin{matrix}36.99\text{ Beer}\\45.5.\text{Wine}\end{matrix}\right\}\text{Gallons}$$

That is ; the Extent from the Firſt Term to the Second, twice turned over from the Third, gives the Gallons required.

Prob. XXXVII. 7. *To meaſure a Ship, that is, to find her Tunnage.*

The Rule. 1. Say, as 1 ·· Breadth : : Half Breadth .. Fourth Number.

2. Then; As 94 .. 4th *Number* : : *Length* .. *Tuns* required.

Example. A Ship 75 Feet by the Keel, and 23 Feet by the Beam: What's her Tunnage? *Anſw.* 211 Tuns.

For, As 1 .. 23 : : 11.5 .. 264.5, the 4th Number.
Then, As 94 .. 264.5 : : 75 .. 211 Tuns required.

8. *To meaſure Bales or Caſes, or to give the Tunnage of them; they are Priſms, and their Dimenſions taken by the Decimal Foot, the Content in Cubic Feet is found by Problem* 31. And then ſay,

As 66 .. 1 : : Cubic Feet .. Tuns required.
Or thus, As 66 .. *Area Baſe* : : *Length* .. Tuns required.

Example. A *Bale* whoſe $\left\{\begin{array}{l}\text{Breadth}\\ \text{Depth}\\ \text{Length}\end{array}\right\}$ is Feet $\left\{\begin{array}{l}4.2\\ 2.6\\ 5.7\end{array}\right\}$ given.

What's the Content in Tuns? *Anſw.* 0.943 Parts. For
As 1 .. 4.2 : : 2.6 .. 10.92 *Area of its Baſe*: Then,
As 66 .. 10.92 : : 5.7 .. *Tuns*, 0.943 Parts required.

Note, That 66 Feet is the Content of a Caſe that incloſeth two *Engliſh Butts*, ſo that this *Rule* includes the *Cantlings* of the *Caſk*, which is better than $\frac{1}{3}$ part; therefore allowing the *Cantlings* or *Vacancy* to be 26 Feet, the remaining 40 Feet is to be counted for a Tun: And,

Then will the foreſaid *Bale* contain *Tun* 1.556 parts. For, The Rule is, As 40 .. *Area Baſe* : : Length .. Tuns req.
As 40 .. *Area Baſe* 10.92 : : *Length* 5.7 .. *Tun* 1.556 parts.

So much for *Geometry*; *Trigonometry* is next in order to be learned.

Chap. II. *Containing the Doctrine of* Plane-Triangles.

Trigonometry, is that part of *Geometry*, which treats more particularly about the meaſuring of Triangles, wherein having three things given, either all Sides, or Sides and Angles, or Angles only in Spherics; a 4th (Side or Angle may be found; and is either *Plane* or *Spheric*; It's the former we begin with.

Sect. I

Section I. *Of Things neceſſary to be underſtood, relating to Plane Trigonometry.*

1. A *Triangle*, is any Three-corner'd Figure; it conſiſteth of Six Things, Three Sides and Three Angles, and is either Plane or Spheric.

2. A Plane Triangle is projected on a Plane or Flat Superficies, and therefore its Sides are Right-lines; but the Sides of a Spheric Triangle, are Arcs of the Sphere, of which, more in the Chapter of Spheric Trigonometry.

3. An *Angle* is the meeting of any two Lines, making a Corner; and is either a Right-angle, containing juſt 90 deg. or Oblique more than 90 deg. called an Obtuſe-angle, or leſs than 90 deg. called an Acute-angle.

4. When two Lines croſſing one another, make the Angles on every ſide equal, then thoſe Angles are Right, and the Lines are Perpendicular.

5. A *Degree*, is the 360 part of the Periphery of any Circle; the 4th Part, 90, is called a Quadrant, and the half, 180, is a Semicircle; Alſo a Degree containing 60 Min. and a Min. 60 Seconds, *&c.* as in Prob. IX. Defin. 1. of Geometry, in page 15.

6. By Complement of any Number of Degrees, underſtand what thoſe Degrees want of 90.

7. A Triangle, is either Right-angled, having one Right-angle; or Oblique, having no Right-angle.

8. In a Right-Angle-Triangle, the Side oppoſite to the Right-Angle, is called the Hypotenuſe, and the two Sides containing the Right-Angle, are called Legs.

9. In all *Plane Triangles*, the Sum of the three Angles added together, are equal to 180 Degrees.

10. The Angles (of a Plane Triangle) being only given, the Proportion of the Sides can only be determined; therefore,

11. In a Right-Angle-Triangle, two things given (one of them a Side) are ſufficient to find a Third: But,

12. In *Oblique-Triangles* three things, and one of them a Side, muſt be given to find a Fourth.

13. Three Letters ſignify an Angle; as BAC ſignify the Angle A: And two Letters a Side, as AB ſignify the Side AB, *&c.*

14. Given Things, whether Sides or Angles, are marked with a *Daſh*, thus (′,) and required Things, with a *Cypher*, thus (°,)

15. $\left\{\begin{array}{l}\text{d.}\\ \text{m.}\end{array}\right\}$ after any Number ſignifies $\left\{\begin{array}{l}\text{Degrees,}\\ \text{Minutes,}\end{array}\right\}$ thus 25d. is 25 Degrees, and 31m. is 31 Minutes.

S.	ſtands for	Sine.
S. c.		Sine Complement, or Co-Sine.
T.		Tangent.
T. c.		Tangent-Complement, or Co-Tan.
Sec.		Secant.
Sec. c.		Secant-Complement, or Co-Secant.
Co. Ar.		Complement Arithmetic.
··		is to, or to the
: :		ſo as; As thus, 2 ·· 4 : : 3 ·· 6.

That is, As 2 is to 4, ſo is 3 to 6.

16. There are ſeven Caſes in Right-Angle-Triangles, and Six in Oblique. Their Solutions follow: but firſt of Right-Angle-Triangles.

Section II. *The firſt Axiom, and the ſeven Caſes of Plane Right-Angle-Triangles depending thereon.*

Axiom 1. IN all Plane Right-Angle-Triangles, if one of the Sides be made Radius, the other two will be either Sines, Tangents, or Secants; That is,

1. If the Hypotenuſe be Radius, each Leg is the Sine of its oppoſite Angle, See *Plate* 2. *Fig.* 1. marked for the firſt Axiom.

2. If one Leg be Radius, the Hypotenuſe is a Secant, and the other Leg is a Tangent of the Angle oppoſite to this Leg, See *Plate* 2. *Fig.* 2. titled for the firſt Axiom.

Note 1. To find a Side, any Side may be Radius, ſaying thus;
As the Word on the Side given, is to the Side given;
So is the Word on the Side required, to the Side required.

Note 2. To find an Angle, one of the given Sides muſt be Radius: Then ſay,
As one given Side, is to the Word on it;
So is the other given Side, to the Word on it.
Obſerve to begin with the Side made Radius.

And what Proportion the Side made Radius, hath to Radius; the ſame hath the other Sides, to the Sines, Tangents, or Secants by them repreſented; and the contrary: And,

Theſe two Notes (to the diligent Reader) are ſufficient to frame any Proportion by the firſt Axiom, making any Side of a Right-Angle-Triangle the Radius.

Problem I. Caſe 1. *The Angles, and Hypotenuſe given; to find either of the Legs.*

Exam. In the Right-Angle-Triangle ABC, *Plate* 2. *Fig.* 1.

$$\text{The}\left\{\begin{array}{l}\text{Hypot. AC 121 Leag.}\\ \text{Angle BAC 54d. 30m.}\end{array}\right\}\text{given: Leg}\left\{\begin{array}{c}\text{AB}\\ \text{BC}\end{array}\right\}\text{required.}$$

This Triangle is made by *Prob.* 10. of *Geometry*, in Page 17.

If you make the Hypotenuſe AC Radius, the Proportion (by *Axiom* 1. and *Note* 1.) is thus,

As Radius, is to the Hypotenuſe AC; ſo is the Sine of the Angle BAC, to the Leg. BC. Or thus briefly;

Radius ·· Hypot AC : : S. BAC. ·· Leg BC.
S. 90d.——121 Leag. 54d. 30m.
9.910686
2.082785
———— Leag,
~~1~~1.993471|98.51 parts.

To work Proportions by Logarithms, obſerve this General Rule: Add the Logarithm of the Second and Third Terms together; and from that Sum ſubtract the Logarithm of the firſt Term, the Remainder is the Logarithm of the fourth Term, or Number ſought.

As in the foregoing Proportion, the Sum of the Logarithms of the ſecond and third Terms added together is 11.993471, from which it is eaſy to ſubtract the Logarithm of the firſt Term (being Radius) by cancelling (cutting off, or leaving out) the firſt Figure to the Left-hand, and then it is ~~1~~1.993471, which brings forth 98.51; that is, Leagues 98.51 Parts of 100 for the Leg BC, the fourth Term, or Side required.

By Gunter's Scale, thus,

Radius ·· AC : : S. BAC ·· BC. That is,
S. 90d. ·· 121 Leag. : : S. 54d. 30m. ·· Leag. 98.5 Tenths.

That is to ſay, the Extent from Sine 90d. (on the Line of Sines) to 121 Leagues (on the Line of Numbers) will reach from Sine 54d. 30m. (on the ſame Sines) to Leagues 98.5 Tenths, (on the Line of Numbers) for the Leg BC, nearly as above.

Obſerve the like in all that follows, except in thoſe Proportions wherein is the Word Secant, which is wrought only by the Logarithms.

The three ſeveral Proportions, making each Side Radius, to find the Leg BC, are theſe which follow.

$$\left.\begin{array}{l}\text{Radius} \cdot\cdot \text{S. BAC}\\ \text{Sec. BAC} \cdot\cdot \text{T. BAC}\\ \text{Sec. ACB} \cdot\cdot \text{Radius}\end{array}\right\} : : \text{Hypotenuſe AC} \cdot\cdot \text{Leg BC.}$$

Likewiſe to find the Leg AB, they are theſe following.

$$\left.\begin{array}{l}\text{Radius} \cdot\cdot \text{S. ACB}\\ \text{Sec. BAC} \cdot\cdot \text{Radius}\\ \text{Sec. ACB} \cdot\cdot \text{T. ACB.}\end{array}\right\} : : \text{Hypotenuſe AC} \cdot\cdot \text{Leg AB.}$$

Note; When Radius is not the firſt Term in the Proportion, then take the Complement-Arithmetic of the Logarithm of the firſt Term; (which how to find, is ſhew'd in Chap. 1. Sect. 2. Propoſition 9. of the Uſe of the Table of Sines, Tangents and Secants, in Page 300.) This Comp. Arith. or Co. Ar. add to the Logar. of the Second and Third Terms, and from the Characteriſtic of their Sum ſubtract 10 or 20, the remaining Figures is the Logarithm of the Fourth Term ſought; as may be ſeen in the following Proportion in Problem II.

Prob. II. Caſe 2 and 3. *The Angles and one Leg given; to find the Hypotenuſe, and the other Leg.*

Example In the Right-Angle-Triangle ABC. *Plate* 2. *Fig.* 2.

$$\text{The} \left\{\begin{array}{l}\text{Angle ACB } 35^{d}.\ 30^{m}.\\ \text{Leg BC 98 Leagues}\end{array}\right\} \text{given:} \left\{\begin{array}{l}\text{Hyp. AC}\\ \text{Leg AB}\end{array}\right\} \text{req.}$$

This Triangle is made by *Prob.* 12. of Geometry, *P.* 17 & 18.

1. To find the Hypotenuſe AC, make it Radius, and the Proportion (by *Axiom* 1. and *Note* 1.) is thus,

As the Sine of the Angle BAC, is to the Leg BC; ſo is Radius, to the Hypotenuſe AC. Or thus,

S. BAC ·· Leg BC : : Radius ·· Hypotenuſe AC.

$$\begin{array}{rl} 54^{d}.\ 30^{m}.\ 98\ \text{Leg.} & \\ \hline & 10.000000\\ & 1.991226\\ \text{Co. Ar.} & 0.089314\\ \hline & \cancel{1}2.080540 \Big(\begin{array}{l}\text{Leag.}\\ 120\ \frac{4}{10}\end{array} \end{array}$$

By Gunter's Scale, *thus*;

S. B A C ·· Leg BC : : Radius ·· Hypotenuſe AC. That is,

S. 54° 30′ ·· 98 L. : : S. 90d ·· Leagues 120.4 Tenths,

That is, the Extent from Sine of 54d. 30m. (on the Line of Sines) to 98 Leagues, (on the Line of Numbers) will reach from Sine 90d. to Leag. 120.4 Tenths, the Hypotenuſe required.

Th

The three ſeveral Proportions, making each ſide Radius, to find the Hypotenuſe, are theſe following.

$$\left.\begin{array}{l}\text{S. BAC} \cdot\cdot \text{ Radius}\\ \text{T. BAC .. Sec. BAC}\\ \text{Radius .. Sec. ACB}\end{array}\right\} : : \text{Leg BC} \cdot\cdot \text{ Hypotenuſe AC.}$$

And to find the Leg AB, they are theſe;

$$\left.\begin{array}{l}\text{S. BAC} \cdot\cdot \text{ S. ACB}\\ \text{T. BAC} \cdot\cdot \text{ Radius}\\ \text{Radius} \cdot\cdot \text{ T. ACB}\end{array}\right\} : : \text{Leg BC} \cdot\cdot \text{ Leg AB.}$$

Note; In working by *Gunter*, when a Tangent is mentioned, the Radius then is the Tangent of 45d. as in the two laſt Proportions, it is,

As T. BAC ·· Radius : : Leg BC ·· Leg AB. Which is,
T. 54d. 30m. ·· T. 45d. : : 98 Leag. ·· Leag. 69.9 Tenths,

That is, the Extent from 54d. 30m. to 45d. (on the *Line of Tangents*) will reach from 98 Leagues, to Leagues 69.9 Tenths on the *Line of Numbers*, for the Leg AB.

As Rad. ·· T. ACB : : Leg BC ·· Leg AB. Which is,
T. 45d. ·· T. 35° 30′ : : 98 Leag. ·· Leag. 69.9 Tenths.

That is, the Extent from T. 45d. to T. 35d. 30m. will reach from 98 Leagues, to Leagues 69.9 Tenths, as before.

Prob. III. Caſe 4 and 5. *The Hypotenuſe and one Leg given, to find the Angles and the other Leg.*

Example. In the Right Angle-Triangle ABC, *Plate* 2. *Fig.* 3.

$$\text{The} \left\{\begin{array}{l}\text{Hyp. AC 121}\\ \text{Leg AB 69}\end{array}\right\} \text{Leagues given} \left\{\begin{array}{l}\text{ACB or BAC}\\ \text{and Leg BC}\end{array}\right\} \text{req.}$$

This Triangle is made by *Prob.* 11. of *Geometry*, *Page* 17.

1. To find the Angles.

If you make the Hypotenuſe AC Radius, the Proportion (by *Axiom* 1. and *Note* 2.) is thus;

As the Hypotenuſe AC, is to Radius; ſo is the Leg AB, to the Sine of the Angle ACB. Or thus,

Hypot. AC ·· Rad : : Leg AB ·· S. ACB.
121 Leag. ·· 90d. : : 69 Leag. ·· S. 34d. 46m. Which
ſubtract from ———————— 90d. 00m.
Remainder is Angle BAC ——— 55d. 14m. by the 9th of *Section* 1. of this *Chapter* in Page 35.

And if the Leg AB is Radius, then the Proportion (by *Axiom* 1. and *Note* 2.) is thus.

As the Leg AB, is to Radius; ſo is the Hypotenuſe AC, to the Secant of the Angle BAC. Or thus,

AB 69 Leag. ·· Radius : : AC 121 Leag. ·· Sec. BAC 55d. 14m.

Note; This Proportion is not wrought on the Gunter becauſe of the Word *Secant* in the 4th Term; but being wrought by the *Tables* (as before directed) will produce the Angle BAC 55d. 14m. as above; which ſubtracted from 90d. gives 34d. 46m. for the Angle ACB, as before.

2. The Leg BC may be found by the 1ſt or 2d Caſe ſeveral Ways: As thus,

$$\left.\begin{array}{llll}\text{Radius} & \cdot\cdot\ \text{AC} & : : & \text{S. BAC}\\ \text{S. ACB} & \cdot\cdot\ \text{AB} & : : & \text{S. BAC}\\ \text{Sec. BAC} & \cdot\cdot\ \text{AC} & : : & \text{T. BAC}\\ \text{Radius} & \cdot\cdot\ \text{AB} & : : & \text{T. BAC}\\ \text{Sec. ACB} & \cdot\cdot\ \text{AC} & : : & \text{Radius}\\ \text{T. ACB} & \cdot\cdot\ \text{AB} & : : & \text{Radius}\end{array}\right\}\cdot\cdot\ \text{BC Leagues 99.4 Tenths,}$$

Prob. IV. Caſe 6 and 7. *The Legs given; to find the Angles, and Hypotenuſe.*

Examp. In the Right-angle Triangle ABC. *Plate* 2. *Fig.* 4.

$$\text{The Leg}\left\{\begin{array}{l}\text{AB 98}\\ \text{BC 69}\end{array}\right\}\text{Leag. given:}\left\{\begin{array}{l}\text{Angle BAC or ACB}\\ \text{and Hypotenuſe AC}\end{array}\right\}\text{req.}$$

This Triangle is made by *Prob.* 13. of *Geometry.*

1. Make the Leg AB Radius, and the Proportion (by *Axiom* 1. and *Note* 2.) is thus,

As the Leg AB, is to Radius; ſo is the Leg BC, to the Tangent of the Angle BAC. Or thus,

Leg AB ·· Leg BC : : Radius ·· T. BAC.
98 Leag. ·· 69 Leag. : : T. 45d. ·· T. 35d. 09m. which
Subtract from ———————— 90d. 00m.

The Remainder is ———————— 54d. 51m. the Angle ACB, by the 9th of *Section* I. of this *Chapter*, in *Page* 35.

And if the Leg BC be made Radius, the Proportion is thus;

Leg BC ·· Leg AB : : Radius ·· T. ACB.
69 Leag. ·· 98 Leag. : : T. 45d. ·· T. 54d. 51m. as before,

Which being ſubtracted from 90, leaveth 35d. 09m. for the Angle BAC. Either of theſe Proportions is ſufficient to find both Angles.

2. The Hypotenuſe AC may be found (by the 2d Caſe) ſeveral ways.

Firſt, Making the Hypotenuſe AC Radius; thus,

$$\left.\begin{array}{l}\text{S. BAC .. BC}\\ \text{S. ACB .. AB}\end{array}\right\} : : \text{Radius .. Hypotenuſe AC.}$$

Secondly, making the Leg AB Radius, thus,

$$\left.\begin{array}{l}\text{Radius .. AB}\\ \text{T.BAC .. BC}\end{array}\right\} : : \text{Sec. BAC .. Hypotenuſe AC.}$$

Thirdly, making the Leg BC Radius; thus,

$$\left.\begin{array}{l}\text{Radius .. BC}\\ \text{T.ACB .. AB}\end{array}\right\} : : \text{Sec. ACB .. Hypotenuſe AC.}$$

Theſe ſix Proportions, if the Learner works them, he'll find them all to Produce Leagues 119.8 for the Hypotenuſe AC.

Note; The 5th and 7th Caſes may be perform'd by the 47th Propoſition of the *Firſt Book of Euclid's Elements*, which proves the Square of the Hypotenuſe, is equal to the Sum of the Squares of the two Legs; Therefore,

1. By common Arithmetic, Extracting the Square Root; the Rules are theſe,

Firſt, In the 5th Caſe to find a Leg; when the Hypotenuſe, and one Leg is given; Thus,

The Square Root of the Difference of the Squares of the Hypotenuſe and one Leg, is the other Leg.

Secondly, In the 7th Caſe to find the Hypotenuſe, when both the Legs are given; thus,

The Square Root of the Sum of the Squares of both Legs, is the Hypotenuſe.

2. By Logarithms in theſe two Rules following.

Firſt Rule, When the Hypotenuſe, and one Leg is given, to find the other Leg, thus,

Half the Sum of the Logarithms of the Sum, and Difference of the Hypotenuſe, and given Leg; is the Logarithm of the Leg required.

Second Rule. When both Legs are given, to find the Hypotenuſe, it is thus.

From the double Logarithm of the greater Leg, ſubtract the Logarithm of the leſſer Leg; the abſolute Number anſwering to it, add to the leſſer Leg; half the Sum of the Logarithms of that Sum, and leſſer Leg, is the Logarithm of the Hypotenuſe required.

Examp.

Example 1. The *Hypotenuſe* AC 121 Leagues, and the Leg AB 69 Leagues: What is the Leg BC by the *Square Root?*

Hypotenuſe AC———121 And *Leg* AB———69
121 69
121 621
242 414
121 *Square* of AB is 4761

Square of AC is——— 14641
Square of AB is——— 4761

Diff. of the Squares is——— 9880(99.39 is the *Leg* BC.
81
189)1780
1701
1983)7900
5949
19869)195100
178821

Remainder is———16279
So that the *Leg* BC is Leagues 99.39 Parts of 100.

By Logarithms, thus.

The *Hypotenuſe* AC——— 121 Leagues.
The given *Leg* AB——— 69 Leagues.

Sum of AC and AB——— 190 its *Logarithm* is 2.278754
Difference of AC and AB——— 52 its *Logarithm* is 1.716003

The Sum of the *Logarithm* is——— 3.994757

The half Sum of theſe *Logarithms*——— 1.997378

Whoſe abſolute Number is 99.39; that is, *Leagues* 99.39 Parts of 100 is the Leg BC, as before.

Example 2. The *Leg* AB is 98 Miles, and the *Leg* BC 69 Miles given: What is the *Hypotenuſe* AC? by the *Square Root.*

The

The Leg AB ——	98	And Leg BC ——	69
	98		69
	784		621
	882		414
Square of AB is ——	9604	Square of BC ——	4761

Square of AB is —— 9604
Square of BC is —— 4761
Sum of the Squares is —— 14365(119.8 that is 119 Leagues $\frac{8}{10}$ is the Hypotenuſe AC.
1
21)043
21
229)2265
2061
2388)20400
19104
Remainder is —— 1296

By Logarithms, thus,

The greater Leg AB 98, its Logarithm is ——	1.991226
Multiply its Logarithm by ——	2
The double Logarithm of the Leg AB is ——	3.982452
The leſſer Leg BC 69 Miles, its Logarithm is ——	1.838849
Abſolute Number 139.2 anſwering the Logerithm is	2.143603
Sum is —— 208.2 its Logarithm is ——	2.318481
The leſſer Leg BC 69 Miles, its Logarithm is ——	1.838849
The Sum of the two laſt Logarithms is ——	4.157330
The half is the Logarithm of AC 119 $\frac{8}{10}$ required	2.078665

Section III. *Three other Axioms, with the ſix Caſes of Oblique Plane Triangles thereunto belonging.*

Axiom 2. IN all Plain Triangles, the Sides are in ſuch Proportion one to another, as are the Sines of their oppoſite Angles, That is,

1. As the Sine of any one Angle, is to its oppoſite Side; ſo is the Sine of any other Angle, to its oppoſite Side.

2. As a Side, is to the Sine of its oppoſite Angle: ſo is any other Side to the Sine of its oppoſite Angle.

Note; To find a Side, begin with an Angle; but to find an Angle, begin with a Side.

From that *Axiom* are drawn the Proportions for the Firſt, Second, and Third Caſes following.

Prob. V. Caſe 1. *Of Obliquangles. Two Angles, and one Side given; to find either of the other Sides.*

Example. In the Oblique Triangle BDC. *Plate* 2. *Fig.* 5.

The { Angle { BDC 101d. 25m. / CBD 44^{d}. 42m. ; Side —— BC 76 Yards. } given : Side { CD and BD } req.

This Triangle is made by *Prob.* 14. of *Geometry*, in Pages 18 and 19.

1. The Proportion according to the Second Axiom for finding the Side CD, is this;

As the Sine of the Angle BDC, is to the Side BC; ſo is the Sine of the Angle CBD, to the required Side CD. Or thus,

S. BDC .. Side BC : : S. CBD .. Side CD required.
S. 101d. 25m. .. 76 Yards : : S. 44^{d} 42m. .. Yds. 54.53 hund.
180d. 00m.

S. 78^{d}. 35m.

Note; The Sine of 101d. 25m. is found by ſubtracting it from 180d. according to Chapter 1. *Section* 2. *Propoſition* 8. *Of the Uſes of the Tables of Sines, Tangents*, &c. in Page 300.

2. To find the Side BD, the Proportion is,

S. BDC. .. Side BC : : S. BCD. .. Side BD.
S. 101d. 25m. .. 76 Yards : : S. 33^{d} 53m. .. Yds. 43.23 hund.
180d. 00m.

S. 78^{d}. 35m.

Problem VI. Caſe 2 and 3. *Of Obliquangles.*

Two Sides, and an Angle oppoſite to one of them given; to find the other oppoſite Angle, and the third Side.

Note; The given Angle Obtuſe, the Angle ſought is Acute.

But when the given Angle is Acute, and oppoſite to the leſſer given Side then the required Angle is doubtful, whether Acute or Obtuſe, and ought to be determined before the Operation.

Examp. In the Oblique Triangle BCD, *Plate* 2. *Fig.* 6.

Side {BC 106 / DB 65} Yards, Angle BCD 31d. 49m. } given : { Angle BDC Obtuſe, and the Side CD } req.
This Triangle is made by *Prob.* 15. of *Geometry*, in *Page* 19.

1. For the Angle BDC the Proportion is,

As the Side BD, is to the Sine of the Angle BCD; ſo is the Side BC, to the Sine of the Angle BDC required. Or, thus,
Side BD .. S. BCD : : Side BC .. S. BDC.
65 Yards .. S. 31d. 49m. : : 106 Yards .. S. 59d. 17m. which
Subtract from ——————— 180d. 00m.
Remainder is the Angle BDC ——— 120d. 43m.

Note; The Proportion produceth 59d. 17m. for the required Angle: But being Obtuſe, you muſt take it's Supplement to 180d. *viz.* 120d. 43m. as above is done.

2. Find the third Angle by the 9th of Section I. of this Chapter, in *Page* 35. then you may find the Side CD by the firſt Caſe.

This Caſe hath been omitted by moſt, the Reaſon (I ſuppoſe) is the doubtfulneſs of the required Angle; but if determined (before) to be either Acute or Obtuſe, the third Side is limited, and then may be a Caſe as well as any other; and the Proportions may be,

S. BCD .. Side BD : : S. CBD .. Side CD.
S. 31d 49m. .. 65 Yards : : S. 27d. 28m. .. Yds. 56.88. Or,
S. BDC .. Side BC : : S. CBD. .. Side CD.
S. 120d. 43m. .. 106 Yds. : : S. 27d. 28m. .. Yds. 56.88 Tenths, as before.

Axiom 3. IN all Plain Triangles; as the Sum of two Sides, is to their Difference; ſo is the Tangent of the Half-Sum of their two oppoſite Angles, to the Tangent of the Half-Difference of the ſaid two oppoſite and unknown Angles. Then,

Add the half Difference of the Angles to their half Sum, finds the greater Angle; and ſubtract the half Difference from the half Sum, finds the leſſer Angle.

Prob. VII. Caſe 4 and 5. *Two Sides and their contained Angle given; to find either of the other Angles, and the third Side.*

Examp. In the Oblique Triangle BCD. *Plate* 2. *Fig.* 7.
Side {BC 109 / BD 76} Leag., Angle CBD 101d. 30m. } given : { Angle {BDC or / BCD and}, Side CD } req.
This Triangle is made by *Prob.* 16. of *Geometry*, in *Page* 19.

1. For the Angle BDC, and BCD, the Operation is,

Side { BC 109	The three Angles —— 180d. 00m.
Side { BD 76	Subtract the given Angle CBD 101d. 30m.
Sum of Sides 185	The two oppoſite Angles { Sum is 78d. 30m.
Their Diff. 33	The two oppoſite Angles { ½Sum is 39d. 15m.

Then, As the Sum of the Sides BC and BD, is to their Difference; ſo is the Tangent of half the Sum of the Angles BDC and BCD, to the Tangent of half their Difference. Or thus,

Sum BC & BD .. Diff. BC&BD : : T. ½ Sum Angles .. T. ½ Diff.
185 Leagues .. 33 Leagues : : T. 39d. 15m. .. T. 8d. 17m.
The half Diff. of the Angles —— 08d. 17m.
Added, is the greater Angle —— 47d. 32m. BDC } req.
Subtracted, is the leſſer Angle —— 30d. 58m. BCD } req.

2. The Proportion for the Side CD, (by the firſt Caſe of Oblique Triangles) may be this:

S. BCD .. Side BD : : S. CBD .. Side CD.
S. 30d. 58m. .. 76 Leag. : : S. 101d. 30m. .. Leag. 144.7 tenths.

Axiom. 4. FRom the half Sum of the three Sides, ſubtract each Side (but firſt that Side oppoſite to the Angle required, then the reſt) ſeverally, noting the Remainders. Then,

As the Product of the half Sum of the Sides, and firſt Remainder, is to the Product of the other two Remainders; ſo is the Square of Radius, to the Square of the Tangent of half the Angle oppoſite to that firſt Remainder.

Prob. VIII. Caſe 6. *Three Sides given, to find an Angle.*

Example. In the Triangle BCD. *Plate* 2. *Fig.* 8.

The *Side* { BC 105, BD 85, CD 50 } Feet given: Angle { BDC, BCD, CBD } req.

This Triangle is made by *Prob.* 17. of *Geometry*, in *P.* 19 and 20.

The Operation for the Angle CBD. *Feet.*

Side { BC —— 105	The half Sum —— 120. *co. ar.* 7.920819
Side { BD —— 85	The firſt Remainder 70. *co. ar.* 8.154902
Side { CD —— 50	The other 2 *Remain.* { 35 Logar. 1.544068
Sum of Sides — 240	The other 2 *Remain.* { 15 Logar. 1.176091
½ their Sum — 120	Sum 18.795880
From ½ Sum } 70	Tangent — 14d. 02m. — ½ Sum 9.397940
Sub. each ſide } 35	Double — 14d. 02m.
there remains } 15	Produceth 28d. 04m. the Angle CBD.

This *Axiom* finds an Angle at one Operation, yet not being applicable to the inſtrumental way of working Proportions, you have this fourth *Axiom* in other Terms; which finds an Angle at two Proportions, and may be wrought both Inſtrumentally and Logarithmetically.

Axiom 4. Uſeful, when three Sides of a Triangle are given; to find an Angle.

As the longeſt Side, is to the Sum of the two ſhorteſt; ſo is the Difference of the two ſhorteſt, to the Difference of the Segments of the Baſe or longeſt Side.

Note; Let fall a *Perpendicular* (from the *Angle* oppoſite) to the *longeſt Side*, which divideth it into two *Segments*; and the *Oblique Triangle* into two *Right-Angled-Triangles.*

As in the aforeſaid Triangle BCD. *Plate* 2. *Fig.* 8.

Let fall the *Perpendicular* DA, which makes the *Segments* of the *Baſe* to be BA and AC, and the two *Right-Angled-Triangles* BAD and CAD, and the Difference of the Segments BE.

1. To find BE the Difference of the Segments of the Baſe.

Shorteſt Sides ———————— { BD ——— 85 Feet
{ CD ——— 50 Feet

Added, is the Sum of the two ſhorteſt Sides ——— 135 Feet

Subtracted, is their Difference ———————— 35 Feet

Then, as the Side BC, is to the Sum of BD and CD; ſo is the Difference of BD and CD, to BE the Difference of the Segments BA and AC. Or thus.

Side BC ·· *Sum* BD & CD : : *Diff.* BD & CD ·· BE the *Diff.* of *Seg.*
105 Ft. ·· 135 Feet : : 35 Feet ·· 45 Feet.

The Side BC 105 Feet.
Diff. *Segments* BE 45 Feet

Added, is —— 150 } the half is { 75 BA the greater } Seg-
Subtracted is —— 60 } { 30 AC the leſſer } ment

2. The Angles BCD or CBD, may be found by the 4th *Caſe of Right-Angled-Triangles*, in *Page* 39. Thus.

Hypot. BD ·· *Radius* : : *Leg* AB ·· S. ADB.
85 *Feet* ·· S. 90d. : : 75 *Feet* ·· S. 61d. 56m.
Which ſubtracted from ——— 90d. 00m.
Remainder is the Angle CBD —— 28d. 04m. as before.

Thus much for *Plane Triangles*; and to compleat *Trigonometry*, *Spheric* ſhould be next. But I think the Application of this before the *Doctrine* of that, moſt conducible to the *Learner*'s Advantage: Therefore will deſcend to the neceſſary Uſes of Plane Trigonometry in Plane and Mercator's Sailing, which will make way for Spheric Trigonometry.

CHAP. III. *Plane Trigonometry applied in Problems of Sailing by the Plane* Sea-Chart, *commonly called* Plane-Sailing.

AND that nothing may be wanting for the Accompliſhment of Navigation, we will begin now with the *Gregorian Calendar*, and then the Uſe of the Plane-Chart, before we apply Plane Trigonometry to Plane-Sailing.

Section I. The common Notes of the *Gregorian* Calendar, or New Stile, to find the Prime, Epact, Dominical Letter, Eaſter Day, the Moon's Age, Southing, and time of High-water.

Problem I. *To find the Golden Number, Cycle of the Sun, and* Roman *Indiction.*

Definitions, 1. THE Golden Number or Prime, is a Circular Revolution of 19 Years; in which Space of time (it has been ſuppoſed) the Sun and Moon finiſh all their Variety of Aſpects; by this we find the Epact, and conſequently whatever thereon depends.

2. The Cycle, or Circle of the Sun, maketh its Revolution in 28 Years; in which Time all the Variety of Dominical Letters, and Leap-Years expire, and the 29th Year the Circle begins again; which Number aſſiſts in finding the Dominical Letter for any Year, paſt, preſent, or to come.

3. *Roman Indiction* conſiſteth of 15 Years; for once in 15 Years the ſubdu'd Nations were to Pay Tribute to the *Romans*; a thing now out of Uſe with us.

The Rule out of Mr. Street's *Memorial Verſes on the Eccleſiaſtic and Civil Calendar.*

When 1, 9, 3, to the Year hath added been;
Divide by 19, 28, 15.

Example. I would know the Golden Number, Cycle of the Sun, and Roman Indiction for the Year 1757.

The Operation.

r 1757 ———— 1757 ———— 1757
— 1 ———— 9 ———— 3
1758 ———— 1766 ———— 1760
————(92 28)————(63 15)————(117
48 86 26
(10) (2) 110
(5)

Year 1757			
	Golden Number	is	10
	Cycle of the Sun		2
	Roman Indiction		5

n II. *To find the Epact until the Year* 1799 *inclusive.*

ion. The Epact is 11 Days the Year of the Moon
the Sun's Year: the Lunar being 354 Days, and the
r, 365 Days.

. The Epact never exceedeth 29, alters every Year 11,
d to find the Moon's Age, and *Easter-Day.*

. When the Golden Number is 1, the Epact is 0,
; when 2, then 11, *&c.*

The RULE *is,*

d the Golden Number, by *Prob.* 1.
tract 1 from the Golden Number, what reſts divide by
ote the Remainder.
ltiply the Remainder by 10, and note the Product.
that Product add the Golden Number leſs 1; the Sum
eeds not 30) is the Epact; but if it doth, ſubtract 30
, and the Remainder is the Epact.

le. For the Year 1757, I demand the Epact?
Year 1757 add 1, and the Sum is 1758, which divide
e Quotient is 92, and the Remainder is 10; ſo that the
Number is 10, ſubtract 1, there reſts 9, which divide by
otient is 3, and the Remainder is 0; which multiply by
to which add 9, equal to the Golden Number leſs 1, the
the Epact for the Year 1757, the ſame as the Golden
leſs 1.

roblem III. *To find the Biſſextiles or Leap-Years.*

Old or Julian Leap-Year, is every fourth Year, and ſo
m its leaping a Day more that Year, than in a common
or in the common Year, any fixed Day of the Month
ſucceſſively the Day of the Week, but in the Leap-Year,
or leaps over one Day: Theſe Leap-Years (in the New
continued exactly in the ſame Order and Succeſſion as here-
ne Centuries in the next Paragraph taken Notice of, only

the *Learner*'s Advantage: Therefore will deſcend to the nec Uſes of Plane Trigonometry in Plane and Mercator's S which will make way for Spheric Trigonometry.

CHAP. III. *Plane Trigonometry applied in lems of Sailing by the Plane* Sea-Chart, *commonly* Plane-Salling.

AND that nothing may be wanting for the Accompliſh of Navigation, we will begin now with the *Gregorian dar*, and then the Uſe of the Plane-Chart, before we appl Trigonometry to Plane-Sailing.

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Problem I. *To find the Golden Number, Cycle of the Su* Roman *Indiction.*

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3. *Roman Indiction* conſiſteth of 15 Years; for once Years the ſubdu'd Nations were to Pay Tribute to the *R* a thing now out of Uſe with us.

The Rule out of Mr. Street's *Memorial Verſes on the Ecc and Civil Calendar.*

When 1, 9, 3, to the Year hath added been;
Divide by 19, 28, 15.

Example. I would know the Golden Number, Cycle Sun, and Roman Indiction for the Year 1757.

The Operation.

The Year 1757	1757	1757
Add 1	9	3
Sum is 1758	1766	1760
19)——(92	28)——(63	15)——(117
48	86	26
(10)	(2)	110
		(5)

For the Year 1757	Golden Number	is	10
	Cycle of the Sun		2
	Roman Indiction		5

Problem II. *To find the Epact until the Year* 1799 *incluſive.*

Definition. The Epact is 11 Days the Year of the Moon lacketh of the Sun's Year: the Lunar being 354 Days, and the Solar Year, 365 Days.

Note 1. The Epact never exceedeth 29, alters every Year 11, and is uſed to find the Moon's Age, and *Eaſter-Day.*

Note 2. When the Golden Number is 1, the Epact is 0, conſtantly; when 2, then 11, *&c.*

The RULE *is*,

1. Find the Golden Number, by *Prob.* 1.
2. Subtract 1 from the Golden Number, what reſts divide by 3, and note the Remainder.
3. Multiply the Remainder by 10, and note the Product.
4. To that Product add the Golden Number leſs 1; the Sum (if it exceeds not 30) is the Epact; but if it doth, ſubtract 30 therefrom, and the Remainder is the Epact.

Example. For the Year 1757, I demand the Epact?

To the Year 1757 add 1, and the Sum is 1758, which divide by 19, the Quotient is 92, and the Remainder is 10; ſo that the Golden Number is 10, ſubtract 1, there reſts 9, which divide by 3, the Quotient is 3, and the Remainder is 0; which multiply by 10, is 0, to which add 9, equal to the Golden Number leſs 1, the Sum is 9, the Epact for the Year 1757, the ſame as the Golden Number leſs 1.

Problem III. *To find the Biſſextiles or Leap-Years.*

The Old or Julian Leap-Year, is every fourth Year, and ſo called from its leaping a Day more that Year, than in a common Year; for in the common Year, any fixed Day of the Month changeth ſucceſſively the Day of the Week, but in the Leap-Year, it ſkips, or leaps over one Day: Theſe Leap-Years (in the New-Stile) are continued exactly in the ſame Order and Succeſſion as heretofore; the Centuries in the next Paragraph taken Notice of, only excepted.

Beſides which, there is another kind of Leap-Year to be obſerved in the *Gregorian* Account, *viz.* The Year 2000, 2400, 2800 and every Fourth Hundredth Year in this Succeſſion are to be eſteemed Leap-Years, and all other even Hundreds, which by *Old Stile* are accounted Leap-Years, are in the preſent not to be accounted for Leap-Years.

Note, The common Year hath 365 Days in it, but Leap-Year of both Kinds 366, and then *February* hath 29 Days, which in Common Years hath but 28 Days.

Rule 1. For the *Julian* common Leap-Years.

Divide the Year by 4, what's left ſhall be,
For Leap-Year 0, for paſt 1, 2, or 3.

Example 1. The Year 1757; is it a Common Year or Leap-Year?

4)1757(1=the Remainder; or is 1ſt Year after Leap-Year.
439

Example 2. The Year 1760: is it a Common Year or Leap-Year?

4)1760(0=Remainder; is therefore Leap-Year.
440

Rule 2d. For the *Gregorian* Leap-Years.

As every Fourth Hundredth Year (beginning from the Year 2000) is Leap-Year, and all the other even Hundreds, Common Years; cut off two Cyphers towards the Right-hand, and divide the other Figures by 4, the Remainder if 0, points out Leap-Year, but if 1, 2, or 3, ſignifies it to be a Common Year, and the 1ſt, 2d, or 3d Year after Centennial Leap-Year.

Example 1ſt. The Year 1800, is it a Common Year or Leap-Year?

4)18|00(2=Remainder; is therefore a Common Year, and
4 2d Year after Centennial Leap-Year.

Example 2d. The Year 2000, is it Leap-Year or a Common Year?

4)20|00(0=Remainder; is therefore Centennial Leap-
5 Year.

Problem IV. *To find the Dominical Letter until the Year* 1799 *incluſive.*

Definition 1. The Week Days in Calanders, or Almanacks, are expreſſed by the firſt ſeven Letters of the Alphabet; the Letter A, conſtantly anſwering to the firſt Day in the Year; that Letter then that ſtands againſt the firſt Sunday in the Year is called the Dominical Letter.

The Rule. Divide the Year, and 4th thereof by 7;
What's left, ſubtract from 7, the Letter's given.

Note 1. When it's Leap-Year, there are two Dominical Letters; one ſerves to the cloſe of *February*, the other from thence to the Year's-end; 'tis the latter that this Rule finds.

2. The Dominical Letter goeth backward in a Common Year one Letter, but in Leap-Year two Letters.

3. As ſaid before, the Years 1800, 1900, 2100, *&c.* are Leap-Years according to the *Julian*, but common Years according to the *Gregorian* Calendar, therefore will have but one Letter inſtead of two, and conſequently the Order of the Dominical Letters will then be changed.

Examp. For the Year 1757. I demand the Dominical Letter?

The Operation.

The given Year is (by *Prob.* 3.) the firſt Year after Leap-Year. ——————————— } 1757
It's fourth Part is ——————————— 439

The Sum is ——————————— 2196
7)2196(313 Quotient, and Remainder is 5; which
(5 ſubtract from 7, reſts 2 for the Dominical Letter; that is, B.

Problem V. *By the* 19 *Epacts; to find Eaſter Limit, from the Beginning of* March *incluſive.*

Difinitions. 1. Eaſter-Limit is the 14th Day of the Paſchal New-Moon (or the New-Moon neareſt the Vernal Equinox) after the Firſt of *March.*

2. The Vernal Equinox, by the *Gregorian* Calendar is fixed on the 21ſt of *March.*

The RULE.

Find the Epact by *Problem* 2.

If that be leſs than 24, ſubtract it from 44; but if more than 24, ſubtract it from 74; if juſt 24, ſubtract from 73; alſo if it be 25, and the Golden Number more than 11, ſubtract from 73; the Remainder is Eaſter-Limit, or the Day of the Paſchal Full Moon, from the 1ſt of *March* incluſive.

Example. I demand Eaſter-Limit, for the Year 1757.

The Operation.

The Epact for the Year 1757 (by *Problem* 2.) is —— 9
Which ſubtract from ——————————— 44

Remainder is Eaſter-Limit from the 1ſt of *March* 35 Days, or the 4th Day of *April* for Year 1757.

Problem VI. *To find* Eaſter-Day *for any Year.*

Definition. Eaſter-Day, is next Sunday after Eaſter Limit, or Day of the Paſchal Full Moon, and is never before the 22d Day of *March*, nor after the 25th Day of *April*.

The RULE.

1. Find the *Dominical Letter* by Problem 4.
2. And *Eaſter-Limit* by the laſt Problem.
3. The Letter more by 4, from Limit take:
What's left from neareſt Sevens ſhall *Eaſter* make.

Example. For the Year 1757, I demand *Eaſter-Day.*

The Operation.

Dominical Letter (by Prob. 4) is B, or———— 2
T[illegible] it add ———— 4
The Sum is ———— 6
Which ſubtract from *Eaſter-Limit* (found by *Prob.* 5.) —— 35
Remainder is ———— 29
Which ſubtract from neareſt Sevens ———— 35
Remainder is ———— 6

Which added to *Eaſter-Limit* 35, Sum is 41, from which ſubtract *March* 31 Days, remains 10, ſo that *Eaſter-Day* is the 10th Day of *April* for the Year 1757.

Problem VII. *To find the Moon's Age.*

Definition. The Moon's Age is, how many Days are paſt ſince the Day of her Change, which Age never exceeds 30 Days.

The Rule. 1. Find the Epact by *Problem* the 2d.

2. To the Epact add the Day of the Month, and the Number of the Month; the Sum if it exceed not 30, is her Age, but if it doth, ſubtract 30 as oft as you can, and the Remainder is her Age.

Note, The Numbers of the Months are theſe,

January,	*February*,	*March*,	*April*,	*May*,	*June*,
0,	2,	1,	2,	3,	4,
July,	*Auguſt*,	*September*,	*October*,	*November*,	*December*.
5,	6,	8,	8,	10,	10.

Example. The 21ſt of *May* 1757, I demand the Moon's Age?

The Operation.

The Epact (by *Prob.* 2.) for the Year 1757 is ——— 9
To it add the Day of the Month ———— 21
And the Month *May*'s Number ———— 3
The Sum is ———— 33 Days.
Which being more than 30 by ———— 3 Days.
is the Moon's Age required.

Which

Problem VIII. *To find the Moon's Southing.*

Definition. The *Moon's Southing*, is the Time of her coming to, or upon the Meridian; which from the New Moon to her Full, is after Noon; but from the Full to the Change, is before Noon.

The Rule 1. Find the Moon's Age by the laſt *Problem.*

2. Multiply her Age by 4, and divide the Product by 5; the Quotient is Hours, and the Remainder is ſo many times 12 Minutes of an Hour, and both together is her Southing.

Example. The 21ſt of *May*, 1757; I demand the Moon's Southing?

The Operation.

The Moon's Age (by *Prob.* 7.) is ———————— 3 Days
Multiply by ———————————— 4

The Product is ———————————— 12

That divided by 5, the Quotient is 2 Hours, and the Remainder is 2, which makes 24 Minutes; ſo that the Moon's Southing is 2 Hours 24 Minutes in the Afternoon.

Prob. IX. *To find the Time of Full Sea, or High-Water, at any Place.*

The Rule. 1. Find the Moon's Southing by the laſt *Problem.*

2. To the Southing, add the Point of the Compaſs making Full Sea, (on the Full and Change Day) for the Place propoſed; that Sum is the Time of Full Sea, or High-water.

Note. The Point of the Compaſs making Full Sea on the Full and Change Days, may be found (in the *Tide-Table)* in the *Mariner's Calendar.*

Example. The 21ſt of *May*, 1757; I demand the Time of High-Water at *London.*

The *Operation.* The Moon's Southing (by *Prob.* 8.) for the
21ſt of *May*, 1757 is ———————— 2 h. : 24m. Afternoon
To it add *London* SW. and NE. ——— 3 h : 00m.

Sum is the Time of High-Water ——— 5 h : 24m. Afternoon

Sect. II. *The Uſe of the* Plane-Chart, *or* Plot.

IT's requiſite to underſtand the Plane-Chart before the Caſes of Plane-Sailing: For it conduces much to the Knowledge thereof; and for the better underſtanding of it, mind theſe following

Definitions. 1. The *Plane Chart* ſuppoſeth the Earth and Sea to make one flat Superficies, or Long-ſquare; in which the Meridians are Parallel, and the Degrees of Latitude and Longitude, equal in all Places; which is only true in the Equator.

2. The Equator is a Line drawn Eaſt and Weſt, and is 90 degrees diſtant from each Pole: From it Latitude beginneth, and on it Longitude is counted.

3. The Poles are two oppoſite Points, one called the North Pole, the other the South Pole; and lie North and South from each other; at them is the greateſt Latitude 90 Degrees.

4. The Meridians are Lines (in this Chart) parallel to each other, and perpendicular to the Equator, and lie North and South; on which are counted the Degrees of Latitude.

5. Parallels of Latitude, are Lines parallel to the Equator, and lie Eaſt and Weſt.

6. Latitude is the Breadth, or Diſtance of any Parallel of Latitude from the Equator; from whence its counted both ways to each Pole, ending in 90 Degrees, the greateſt Latitude.

7. North Latitude, is on that ſide of the Equator towards the North Pole; and South Latitude towards the South Pole.

8. Difference of Latitude is the Breadth, or neareſt Diſtance of any two Parallels of Latitude; and ſheweth how far one Place lies to the Northward, or Southward of the other; it never exceedeth 180 Degrees.

9. Longitude (in the Plane Chart) is reckon'd on any Parallel of Latitude, and increaſeth to the Eaſtward, till it end in 360 Degrees, the greateſt Longitude.

10. Difference of Longitude, Meridian Diſtance, and Departure from the Meridian, ſignify (in the Plane Chart) one and the ſame thing, and is the neareſt Diſtance of any two Meridians; it ſheweth how far one Place is to the Eaſtward, or Weſtward of another.

The Uſe of the Plane-Chart.

Prob. 1. *To find the Latitude of any Place in the Chart.*

Rule 1. Take the neareſt Diſtance of the Place to any Parallel or Eaſt and Weſt-Line.

2. Lay that Diſtance on the graduated Meridian, ſetting one Foot of the Compaſſes in the ſaid Parallel, and turning the other Foot the ſame Way, the propoſed Place lieth from it; the laſt Foot ſheweth the Latitude required.

Example,

Examp. What Latitude doth the *Lizard* in *England* lie in?

1. Take the neareſt Diſtance from the *Lizard* to any Parallel, or Eaſt and Weſt Line.

2. Lay that Diſtance (on the graduated Meridian) from the ſaid Parallel, and the moveable Foot ſheweth 49d. 57m. the Latitude of the *Lizard*; and it is North Latitude, becauſe Northward of the Equator: do ſo for any other Place.

Prob. 2. *To find the Courſe, or Bearing of one Place from another.*

The Rule is,

1. Lay a Ruler on the two Places given; and take the neareſt Diſtance from the Center of any Compaſs to the Ruler's Edge.

2. Slide the Compaſſes, (being at that Diſtance) with one Foot cloſe to the Ruler, and the other Foot perpendicular to it; in ſo doing the perpendicular Foot points (among the Rumb-lines) the Courſe, or Bearing of the propoſed Places, from one another.

Example. I demand the Courſe from the *Lizard* in *England*, to the Iſland of *Barbadoes*.

1. Laying a Ruler's Edge on the *Lizard* and *Barbadoes*, take the neareſt Diſtance from the Center of a Compaſs to the Edge of the Ruler.

2. Slide the Compaſſes along by the Ruler, keeping one Foot perpendicular to it, and it ſheweth (among the Rumbs) the Courſe to be SW. half W. neareſt, from the *Lizard* to the Iſland of *Barbadoes*; the oppoſite Point (viz.) NE. half E. is the Courſe from the Iſland *Barbadoes* to the *Lizard*.

Problem 3. *To find the Diſtance of one Place from another.*

The Rule. Extend the Compaſſes from one Place to another. Meaſure that Diſtance on a Scale or Leaguess, or on the graduated Meridian; the firſt ſheweth the Diſtance in Leagues; the latter in Degrees. This is ſo eaſy, it needs no Example.

Problem 4. *To find the Departure, or Meridional Diſtance between any two Places in the* Chart.

1. *The Rule.* Take the neareſt Diſtance from one of the given Places, to any Meridian.

2. The Compaſſes being kept at that Diſtance, move them Perpendicular along that Meridian, till you bring both Feet of the Compaſſes into the Parallel of the other Place, there ſtay the Compaſſes.

3. The Diſtance from the Perpendicular Foot, to the other propoſed Place, being meaſured on the graduated Meridian, or on the *Scale of Leagues*, giveth the *Meridional Diſtance* required.

Example. I demand the Meridional Diſtance between the *Lizard* and Cape *Finiſterre?*

1. Take the neareſt Diſtance from the *Lizard* to a Meridian, and ſlide the Compaſſes with one Foot on it, and the other Perpendicular, till both Feet come to the Parallel of Cape *Finiſterre.*

2. Then the Diſtance from the Perpendicular Foot, to Cape *Finiſterre*, being meaſured on the Meridian, is 3 Degrees 18 Minutes, or 66 Leagues, which is the Meridional Diſtance, and ſheweth Cape *Finiſterre* is 66 Leagues to the Weſtward of the Meridian of the *Lizard*, and conſequently the *Lizard* lies 66 Leagues to the Eaſtward of the Meridian of Cape *Finiſterre.*

Problem V. *The Latitude a Ship is in, and her Meridional Diſtance given, to find in the Chart where the Ship is.*

The Rule. 1. Lay off the Meridional Diſtance (according to its Nature, whether to the Eaſtward or Weſtward) from the Place its counted from; and then the neareſt Diſtance from that, to any Meridian, muſt be kept in one Pair of Compaſſes.

2. With another pair of Compaſſes, take the neareſt Diſtance of the Latitude, from any Parallel, or Eaſt and Weſt Line.

3. Then move both pair of Compaſſes Perpendicular, one on the Meridian, the other on the Parallel, till both Perpendicular-Feet meet, and there is the Point in the *Chart* repreſenting the Place the Ship is in.

Sect. III. *Plane Trigonometry applied in* Plane-Sailing.

Definition. 1. *NAvigation*, is the guiding or directing a Ship (thro' the Ocean) from one Place to another; its divided into two Generals, Domeſtic and Remote.

2. *Domeſtic*, or Home Navigation, is Coaſting or Sailing along Shore, in which the *Mariner's Compaſs*, and *Lead*, are the chief Inſtruments.

3. *Remote*, (which more properly bears the Name of Navigation) is the conducting a Ship to any Port, and the finding what Latitude and Longitude ſhe is in, at any Time; in the Practice of which, the Mariners have theſe Helps, the Compaſs, the Log, and the Latitude.

4. The Compaſs, is a Circle divided into 4 Quadrants, Quarters, or principal Points; Eaſt, Weſt, North, and South; each Quarter into 8 equal Parts, being in all 32 Rumbs, or Points, as in *Figure* 16. of *Plate* 2. So that ſteering by the Compaſs (well made and duly rectified) is known how, or which way, the Ship ſails to a ſmall Matter.

5. The Log-line, (truly marked, or ſome other good way) is the Inſtrument whereby the Mariners meaſure the Ship's Diſtance ſailed, in Minutes, Miles, or Leagues, every Hour, Watch, or Day.

Note, Each Knot in the Log-line ought to be 50 Feet from each other, and not 42 Feet, or 7 Fathom; an Error too frequent among the *Engliſh* Navigators, and long ſince refuted by Mr. *Norwood* in his *Seaman's Practice*, and ſeveral others ſince that Time.

Alſo the half Minute Glaſs, uſed with the Log-line, ought to be truly 30 Seconds of Time, and not 25 or 26 Seconds, as chiefly made now, which are ſo called.

6. The third Help, is the Knowledge of the Latitude from whence he ſails, to which he is bound, and where the Ship is at any Time; this is attained by Cœleſtial Obſervation (at Sea with a Quadrant or Foreſtaff) taking the Sun or Star's Mer. Altitude.

Now, any two of theſe three Things exactly known, the Navigator comes to know at any Time, where he is, how far he hath run, and how far he is yet to run, which Way, or upon what Point of the Compaſs he is to ſteer; and all this by Trigonometry, in three Kinds, *viz.*

Plane-Sailing, *Wright's-Sailing*, and *Circle-Sailing*, as ſhall be ſhewed in Order: And firſt of Plane-Sailing, in which take theſe Five General Rules following.

Rule 1. That 20 Leagues being equal to 60 Miles, or Minutes, is alſo equal to one Degree of Latitude.

But note, One of theſe Miles or Minutes containeth 6000 Feet, and is greater than a Statute or common Mile, which is but 5000 Feet; of which about 69 ½ Miles make a Degree; whereas in the Practice of Navigation, 60 are counted to a Degree on the Meridian, or any great Circle.

2. *General Rule.* To find the Difference of Latitude, when the Latitudes of two Places are given.

The Latitudes $\left\{\begin{array}{c}\text{both}\\ \text{one}\end{array}\right\}$ North $\left\{\begin{array}{c}\text{or both}\\ \text{the other}\end{array}\right\}$ South $\left\{\begin{array}{c}\text{ſubtract}\\ \text{add}\end{array}\right\}$ finds the Difference of Latitude.

3. *General Rule.* To find the Latitude the Ship is in, when the Latitude ſailed from, and the Difference of Latitude is given; for this are the two following Caſes.

Caſe I.

In $\left\{\begin{array}{l}\text{North}\\ \text{South}\end{array}\right\}$ Latitude ſailing to the $\left\{\begin{array}{l}\text{North}\\ \text{South}\end{array}\right\}$ ward, the Latitude increaſeth, add.

Caſe. II.

In $\left\{\begin{array}{l}\text{North}\\ \text{South}\end{array}\right\}$ Latitude ſailing to the $\left\{\begin{array}{l}\text{South}\\ \text{North}\end{array}\right\}$ ward, the Latitude decreaſeth, ſubtract.

And here *Note*, When the Latitude decreaſeth, and the Difference of Latitude is greater than the Latitude failed from, the Ship hath croſſed the Equator, and changed her Latitude; either from North into South, or South into North.

4. *General Rule.* The Sum of the three Angles of every Plane Triangle, is equal to 16 Points of the Compaſs: For,

$$\left.\begin{array}{l}\text{1 Point}\\ \left.\begin{array}{r}8\\ 16\\ 32\end{array}\right\}\text{Points}\end{array}\right\}\text{of the Compaſs is equal to}\left\{\begin{array}{l}\text{11d. 15m.}\\ \left.\begin{array}{r}90\\ 180\\ 360\end{array}\right\}\text{Degrees.}\end{array}\right.$$

5. *General Rule.* If a Ship ſails Eaſt or Weſt, ſhe keeps in the ſame Latitude; and if a Ship ſails North or South, ſhe keeps in the ſame Longitude.

Note, *Plane-Sailing* is divided into three Parts, *viz.*

1. In a Right-Angle-Triangle, relating to a ſingle Courſe, in which are Six Caſes.

2. In a Right-Angle-Triangle, relating to ſeveral Courſes, called a Traverſe.

3. In an Oblique Triangle, in which are but four Caſes, tho' Multitude of various Queſtions.

The Firſt Part of Plane Sailing is contained in the ſix Problems, or Caſes following.

Prob. *or* Caſe 1. *Courſe, and Diſtance ſailed given; to find the Difference of Latitude, and the Departure from the Meridian.*

Example. Admit a Ship runs 496 Minutes SW. by W. from the *Lizard* in 49d. 57m. North Latitude: I demand the Latitude ſhe is in, and how far ſhe is departed from the Meridian?

Obſerve, That in all Problems of Navigation, make the upper End of the Book or Slate, to be the North; then the Right-hand is the Eaſt, the Left-hand the Weſt, and the lower End is the South. Then,

To delineate this Problem *by the* Plane-Scale.

1. Draw the Meridian AB *(Plate* 2. *Fig.* 9.*)* towards the Right-hand, when the Courſe is Weſterly; but when Eaſterly towards the Left-hand; and put A at the upper End when the Courſe is Southerly, but at the lower End when its Northerly.

2. With a Chord of 60 Degrees, and one Foot on A, deſcribe an Arc; on that Arc lay 5 Rumbs (becauſe SW. by W. is 5 Points from the South) taken from the Scale of Rumbs, and by it draw the Line AC.

3. From any Scale of equal Parts, take the Diſtance run 496 Minutes, and lay it from A to C; then A repreſents the Place ſailed from, C the Place the Ship is come to.

4. From C let fall the Perpendicular CB, to cut the Meridian in B, and its done: Then the meaſure of AB, and BC, on the ſame Scale of equal Parts, that AC was taken from, will ſhew how much the Difference of Latitude, and Departure from the Meridian is, by the Plane Scale.

Theſe Directions with the following Explanation being well conſidered, will ſhew how to delineate, and anſwer any of the Six Caſes of Plane-Sailing by the Plane Scale: Therefore I omit the Delineations in the five following Caſes; having given ſufficient Directions to make any Rectangle-Plane Triangle in Problems 10, 11, 12, and 13 of Practical Geometry, and ſuch are all the Caſes in this Part of Plane-Sailing.

This Right-Angle Triangle ABC, (*Plate* 2. *Fig.* 9.) may be made by Prob. 10. of Geometry; in which *Note*,

1. The Hypotenuſe AC repreſents (the Point of the Compaſs the Ship hath ſteered and) the Ship's Diſtance run.
2. The Leg AB, (the Meridian, that is, the North or South Direction of the Compaſs) the Difference of Latitude.
3. The Leg BC, (the Eaſt or Weſt Direction of the Compaſs, and a Parallel of Latitude) the Departure from the Meridian.
4. The Angle BAC, (the Angle of) the Ship's Courſe.
5. The Angle ACB, (the Angle of) the Complement of the Ship's Courſe.

Note, The Angle which the Point of the Compaſs (ſteered by, or upon) maketh with the Meridian, or North, and South Point of the Compaſs, is called the Angle of the Ship's Courſe, and the Angle it maketh with the Eaſt, or Weſt Point, is the Complement of the Courſe.

The Courſe, in this Example being SW. by W. is 5 Points from the South, or Meridian, and makes 56d. 15m. The Complement of the Courſe is 3 Points; that is 33d. 45m. as may be ſeen in the Table, intitled, A Table of the Angles which every Rumb (or Point of the Compaſs) maketh with the Meridian, at the End of this Book.

The Things thus explained, the Proportion (by *Chapter* 2. *Section* 2. *Axiom.* 1. and Caſe 1. of Plane Right-Angle-Triangles in Pages 36 and 37.) is as follows.

For the Difference of Latitude, theſe three Proportions, viz.

$$\left.\begin{array}{c}\text{Radius}\\ \text{Sec. Courſe}\\ \text{Sec. c. Courſe}\end{array}\right\} \;..\; \text{Diſtance} :: \left\{\begin{array}{c}\text{S. c. Courſe}\\ \text{Radius}\\ \text{T. c. Courſe}\end{array}\right\} \;..\; \text{Diff. Lat.}$$

All theſe three Proportions may be wrought by the Logarithms, but I only work the firſt.

By Gunter's *Scale.*

Radius .. Diſtance : : S. c. Courſe .. Difference of Latitude.
S. 8 Points .. 496 Min. : : S. 3 Points .. Min. 275.6 Tenths
Latitude ſailed from, is ——— 49d. 57m. North.
The Diff. of Latitude, Min. 275.6 or 04d. 36m. Southerly.

Subtract, giveth Latitude the Ship is in, 45d. 21m. North.

For the Departure, theſe three Proportions, viz.

Radius	.. Diſtance : :	S. Courſe	.. Departure.
Sec. Courſe		T. Courſe	
Sec. c. Courſe		Radius	

The firſt of theſe by Gunter's *Scale.*

Radius .. Diſtance : : S. Courſe .. Depart. from the Meridian.
S. 8 Points .. 496 Min. : : S. 5 Points .. Minutes 412.4 Tenths.

So that the Departure from the Meridian is Minutes 412.4 Tenths, which makes 6d. 52m. Meridian Diſtance Weſt.

Prob. *or* Caſe 2. *Courſe and Difference of Latitude given, to find the Diſtance run, and the Departure from the Meridian.*

Example. If a Ship runneth SE. by E. from 1d. 45m. North Latitude, and then (by Obſervation) is in 2d. 50m. South Latitude. What is her Diſtance and Departure? *Plate* 2. *Fig.* 10.

This Triangle ABC may be made by *Prob.* 12. of *Geometry.*

In this *Example*, having Latitude the Ship ſailed from, and Latitude ſhe is in by Obſervation, there are the Latitudes of two Places given; and by the ſecond General Rule, in Page 58. the Difference of Latitude is found, as followeth:

Latitude ſailed from ——————— 1d. : 45m. North
Latitude by Obſervation, is ———— 2d. : 50m. South

The Difference of Latitude, is ——— 4d. : 35m. or 275 Minutes, found by multiplying by 60, the Minutes in a Degree.

1ſt, For the Diſtance, the Proportion may be this;

S. c. Courſe .. Diff. Lat. : : Radius .. Diſtance.
S. 3 Points .. 275 Min. : : S. 8 Points .. 495 Minutes.

2d, For the Departure, this;

S. c. Courſe .. Diff. Lat. : : S. Courſe .. Departure.
S. 3 Points .. 275 Min. : : S. 5 Points .. 411.6 Minutes: Or 6d. 52m. Eaſting; that is, the Ship is ſo much to the Eaſtward of the Meridian of the Place ſhe ſailed from.

Problem, *or* ſe 3. *Courſe, and Departure from the Meridian given* *nd the Diſtance, and Difference of Latitude.*

Exam ſails NE. by E. from a Port in 3d. 15m. South Latitu depart her firſt Meridian 412. Min. I demand her I what Latitude ſhe is in? *Plate* 2. *Fig.* 11. T be made by *Prob.* 12. of *Geometry.*

1ſt, For the Diſtance, the Proportion is this.

S. Courſe .. Departure : : Radius .. Diſtance.
S. 5 Points .. 412 Min. : : S. 8 Points .. Min. 495.5 Tenths.

2d, For the Difference of Latitude, this;

S. Courſe .. Departure : : S. c. Courſe .. Diff. Latitude.
S. 5 Points .. 412 Min. : : S. 3 Points .. 275 Minutes, which being reduced, is 4 Degrees 35 Minutes Northing; by which find the Latitude the Ship is in, as here under.

Latitude ſailed from, is ———————— 3d. 15m. South.
Difference of Latitude, is 275.3 Min. or — 4d. 35m. North.

Subtract, giveth Latitude the Ship is in 1d. 20m. North. having croſs'd the Equator.

Problem, *or* Caſe 4. *Diſtance, and Difference of Latitude given; to find the Courſe, and Departure.*

Example. Suppoſe a Ship ſails 496 Min. between the South and the Weſt, from a Port in 2d. 48m. South Latitude; and then by Obſervation is in 7d. 23m. South Latitude: What Courſe hath ſhe ſteered, and what Departure hath ſhe made? *Plate* 2. *Fig.* 12. This Triangle may be made by *Prob.* 11. of *Geometry.*

By the two Latitudes mentioned in this *Example*, find the Difference of Latitude, as followeth,

Latitude ſailed from, is ———————— 2d. 48m. South.
Latitude by Obſervation, is ———————— 7d. 23m. South.

Subtract, gives the Diff. of Latitude 4d. 35m. or 275 M.

1ſt, For the Courſe, the Proportion is,

Diſtance .. Radius : : Diff. Lat. .. S. c. Courſe.
496 Min. .. S. 90d. : : 275 Min. .. S. 33d. 40m.

Which ſubtract from 90d. the Remainder 56d. 20m. is the Courſe, which makes 5 Points neareſt; SW. by W. is then the Ship's Courſe.

2d, The Proportion for the Departure is,

Radius .. Diſtance : : S. Courſe .. Dep ure.
S. 90d. .. 496Min. : : S. 56d. 20m. .. 41 tes.

Problem, *or* Caſe 5. *Diſtance and Departure find the Courſe, and Difference of Lati*

Examp. Admit a Ship ſails 496 Minutes r
and the Weſt, from the Iſland *Bermudas*, in
North, until her Departure is 412 M

hath ſhe ſteered? And what Latitude is ſhe in? *Plate* 2. *Fig.* 13. This Triangle may be made by *Prob.* 11. of Geometry.

1ſt, For the Courſe, take this Proportion.

Diſtance .. Radius : : Departure .. S. Courſe.
496 min. .. S. 90d. : : 412 min. .. S. 56d. 10m. N. Weſterly.

That is, 5 Points, which makes the Courſe to be NW. by W.

2d, For the Difference of Latitude.

Radius .. Diſtance : : S. c. Courſe .. Difference of Latitude.
S. 90d. .. 496 min. : : S. 33d. 50m. .. 276.1 min. or 4d. 36m.

d. m.
Latitude ſailed from ——————— 32 : 25 North.
Difference of Latitude 276 Minutes, or — 4 : 36 Northerly.

Latitude the Ship is in ——————— 37 : 01 North.

Problem, *or* Caſe 6. *Difference of Latitude and Departure given; to find the Courſe, and Diſtance.*

Examp. If a Ship's Southing be 275 Minutes, and her Eaſting 412 Minutes, What is her Courſe and Diſtance? *Plate* 2. *Fig.* 14. This Triangle may be made by Prob. 13. of Geometry.

1ſt, For the Courſe, take this Proportion.

Diff. Lat. .. Departure : : Radius .. T. Courſe.
275 Min. .. 412 Min. : : T. 45d. .. T. 56d. 17m. South-Eaſterly, or 5 Points, which makes the Courſe to be SE. by E neareſt.

2d, For the Diſtance, this Proportion.

S. Courſe .. Departure : : Radius .. Diſtance.
S. 56d. 17m. .. 412 Min. : : S. 90d. .. 495.3 Min.

The ſix preceding Problems are the common Caſes of Plane-Sailing; which the Learner ought to be well acquainted with: and for that End I here add ſix more for Practice, whoſe Anſwers may be found by the foregoing Rules.

Queſtion 1. *A Ship in* 2d. 10m. *South Latitude, ſails* N. *by* E. 89 *Leagues: What Latitude is ſhe in; and what is her Departure?*

Anſwer. Latitude 2d. 12m. North, and Departure Leagues 17 and 36 Parts of a Hundred.

Queſtion 2. *A Ship ſails* SSW. *from a Port in* 41d. 30m. *North Latitude; and then by Obſervation, the ſaid Ship is in* 36d 57m. *North Latitude: I demand the Diſtance Run, and Departure?*

Anſwer. Diſtance Run 98 Leagues 5 Tenths, Departure Leagues 37.7 Tenths.

Queſtion 3. *A Ship ſails* SSW. *half* W. *from* 2d. 30m. *South Latitude,*

Latitude, until the Departure be 59 *Leagues: I demand her Diſtance Run, and the Latitude ſhe is in?*

Anſ. Diſtance Run 125.2 Leagues, Latitude 8d. 01m. South.

Queſt. 4. *If a Ship ſaileth* 360m. *South Weſtward, from* 21d. 59m. *South Latitude, until (by Obſervation) ſhe be in* 24d. 49m. *South Latitude: What is her Courſe and Departure?*

Anſw. Courſe is SW. by W. half W. and Departure from the Meridian is 317.3 Minutes.

Queſt. 5. *Suppoſe a Ship ſaileth* 354 min. *North Eaſtward, from* 2d. 9m. *South Latitude, until her Departure be* 150 min. *What is her Courſe and Latitude ſhe is in?*

Anſw. Courſe is NNE. a quarter Eaſt neareſt, and Latitude the Ship is in, is 3d. 12m. North.

Queſt. 6. *Sailing between the North and the Weſt, from a Port in* 1d. 59m. *South Latitude, and then arriving at another Port in* 4d. 8m. *North Latitude, which is* 209m. *to the Weſtward of the firſt Port: I demand the Courſe, and Diſtance from the firſt Port to the ſecond.*

Anſw. Courſe is NNW. half W. and Diſtance of the Ports is 422.3 min. or 140.7 Leagues.

So much for the firſt Part of *Plane-Sailing*, *Traverſe* is next in order.

Section IV. *Plane-Sailing, the ſecond Part; ſhewing how to reſolve a Traverſe, or bring ſeveral Courſes into one.*

HAVING learn'd thoſe neceſſary *Problems* concerning a ſingle Courſe, the next in order is a *Compound Courſe*, commonly called a *Traverſe*; in order to the right Underſtanding whereof, obſerve the following Definitions.

1. A *Traverſe*, is when a Ship (meeting with a contrary Wind) ſaileth on ſeveral Courſes in 24 Hours.

2. *To reſolve a Traverſe*, is to reduce or bring ſeveral Courſes into one; the Courſes are known by the Compaſs, and the Diſtance by the Log, which in common Voyages is heav'd once in two Hours, but in Ships of War, or to the *Eaſt-Indies* every Hour.

3. The *Log*, is a Piece of Wood about ſeven Inches long, in Form like a Flounder, with the Head cut off, and ſo faſtened to a ſmall Chord (or Line called the *Log-line*) at one End, with ſo much Lead at the other, that when it's put into the Sea, it may ſwim upright, or End-wiſe.

4. The *Log-line*, is divided into equal Spaces, called *Knots*,

1/3

Pla. 2.

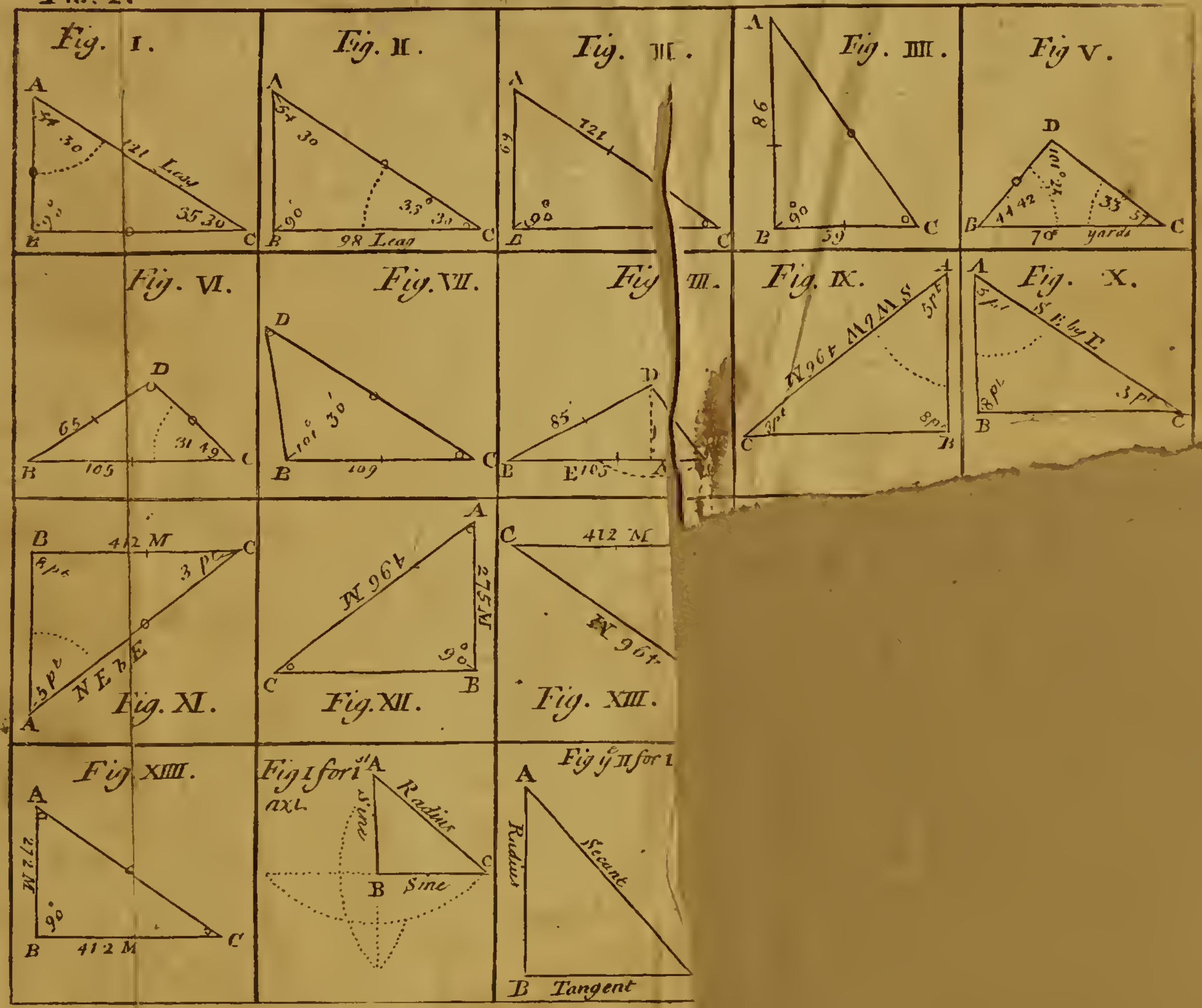

Fig. I.
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Fig. II.
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Fig. III.
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Fig. IIII.
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86
90
59
B
C
Fig V.
D
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44 42
33 57
70
yards
B
C
Fig. VI.
D
65
105
31 49
B
C
Fig. VII.
D
101 30
109
B
C
Fig VIII.
D
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105
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E
A
Fig. IX.
N 96 M
5 pt
3 pt
8 pt
A
B
C
Fig. X.
A
5 pt
S E by E
8 pt
3 pt
B
C
B
412 M
C
8 pt
3 pt
5 pt
N E b E
A
Fig. XI.
A
N 96 M
275 M
90
C
B
Fig. XII.
C
412 M
N 96
Fig. XIII.
Fig. XIIII.
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by ſomething faſtened to it, at every 50 Feet Diſtance for a Knot: Now the *Log-line* being wound on a *Reel*, and the *Log* put into the Sea; if the *Log-line* be veered out ſo faſt as the Ship ſails, then look how many Knots are veered out in half a Minute's Time; and ſo many Miles or Minutes doth the Ship run in one Hour.

5. One of theſe Miles contains 6000 Feet, and is greater than a *Statute* or *common* Mile, that being but 5000 Feet; of which about 69½ (on the Meridan, or any great Circle) make a Degree; but in the Practice of *Navigation*, 60 Miles or Minutes are counted for a Degree, therefore I call them Minutes.

6. *In the ſteerage*, or ſome convenient Place of the Ship, hangeth a *Table* called the *Log-Board*, divided into 5 Columns; wherein are written the *Hours of the Day*, *Courſes ſteered*, *Knots*, &c. veered out; and laſtly the *Winds*; as in the Table following.

The Form of the Log-Board.

Hours of the Day.	*Courſes or Points.*	*Knots.*	*Fathoms. of 5 Feet.*	*Winds.*
H	C.	K.	F.	
2	SW. by S.	7	5	WNW.
4		7	5	W by N.
6	S.	8	6	WSW.
8		8	5	
10	NW. by N. ½ W.	4	8	WSW. ½ W.
12		5	4	
2		5	6	
4	SW.	7	6	WNW.
6		8	5	
8	SE.	4	4	SW by S.
10	SW.	4	5	SSE.
12	ESE.	5	3	S.

Note, The Column for Courſes is made ſometimes juſt before the Column for the Winds, and then the three narrow Columns ſtand together.

7. The Day begins and ends at Noon; that is, from Noon to Noon is the Length of the Day.

8. Every Day at Noon the Log-board ought to be copied into a Log-Book ruled like the Log-board: Then muſt be caſt up how much the Ship hath ſailed on each Courſe.

9. If the Ship ſails by a Wind, it's uſual to allow one Point for Leeward Way; ſo that when the Ship is cloſe hauled, and lieth 5 Points and a half from the Wind, yet her Courſe corrected is 6 Points and a half from the Wind.

10. The ſeveral Courſes (being Corrected) and Diſtances, are to be brought into one Courſe and Diſtance; which is called *Reſolving a Traverſe*, and to lay it down by Scale and Compaſſes, take the four following Rules, which give the Points that are between the Courſe laſt made, and that laid down, next to be called the Angle between both Courſes.

Rule 1. Two Meridians and two Parallels; the leſſer Courſe ſubtracted from the greater, gives the Angle between both Courſes.

Rule 2. Two Meridians, and one Parallel; add both Courſes together.

Rule 3. One Meridian, and two Parallels; ſubtract the Sum of both Courſes from 16 Points.

Rule 4. One Meridian, and one Parallel; add 8 Points, the leſſer Courſe, and the Complement of the greater together; the Sum is the ſaid Angle.

Note 1. North and South are called Meridians, and Eaſt and Weſt are called Parallels.

2. By Complement of the greater Courſe, underſtand how much it wants of 8 Points.

3. To know the Meridians, and Parallels, the firſt and ſecond Courſes are compared together, the Second and third, and the third and fourth, &c.

Example. *A Ship bound to a certain Port, meeting with contrary Winds, ſails firſt* S. E. *by* S. 67 *Miuutes; then* S. E. *by* E. 53; *then* WSW. 45; *then* NE. *by* N. 74; *then* W. 57; *and then* S. *by* E. 83 *Minutes: I demand the Difference of Latitude, Departure from the Meridian, and direct Courſe, and Diſtance from the firſt Place departed?* Plate 2. Fig. 15.

1. Set down the ſeveral Courſes and Diſtances, with the Points from the Meridian, *&c.* as in the following Table.

Number.	*Courſes.*	*Diſt. in Min.*	*Points from the Meridian.*	*Points for Laying down.*	*Diff. Latitude in Minutes.*		*Departure in Minutes.*	
					North.	South.	Eaſt.	Weſt.
1	SE by S.	67	3	3		55.7	37.2	
2	SE by E.	53	5	14		29.4	44.1	
3	W S W.	45	6	5		17.2		41.6
4	NE by N.	74	3	3	61.5		41.1	
5	Weſt	57	8	5				57.0
6	S by E.	83	1	7		81.4	16.2	
Sum'd up					61.5	183.7	138.6	98.6
Subtract						61.5	98.6	
Difference of Latitude						122.2	40.0	Depart.

2. In the fifth Column put the Points for laying down, which are found by the four Rules foregoing; The firſt Courſe always is the ſame with the Points from the Meridian: For the ſecond Courſe, it's 14 Points, found by comparing the firſt and ſecond Courſes together, in which is one Meridian and one Parallel; and by the 4th Rule it makes 14 Points, for laying down: Again, comparing the ſecond and third Courſes, it's one Meridan and two Parallels, which by the Third Rule makes 5 Points for laying down: Again, the third and fourth Courſes compared it's two Meridians and two Parallels; which, by the Firſt Rule makes 3 Points for laying down; and ſo for the reſt, as in the foregoing Table.

3. By theſe Points for laying down, it's eaſy to delineate the Traverſe; as you ſee in *Plate* 2. *Fig.* 15. which is thus:

Firſt, Draw the Meridian AB, and on A draw an Arc, with the Chord of 60 Degrees, on which Arc lay 3 Points; by it draw a SE. by S. Line, laying thereon (from A) 67 Minutes the Diſtance run SE. by S.

Secondly, With a Chord of 60 Degrees, and one Foot at the End of the SE. by S. Line, draw an Arc, (always towards that Point of the Compaſs directed by the Courſe) on which lay 14 Points: That is, take 7 Rumbs from the Scale of Rumbs, and lay it twice on the ſaid Arc; through that Point, and from the End of the SE. by S. Line, draw a SE. by E. Line, making it 53 Minutes long, ſo the ſecond Courſe is finiſhed.

Thirdly, At the end of the SE. by E. Line, in like Manner with the Chord of 60 Degrees, draw an Arc, and thereon lay 5 Points, by which and the end of the SE. by E. Line draw the WSW. Line 45 Minutes long.

Fourthly, After the ſame Manner draw the NE. by N. Line 74 Minutes long: Then the W. Line, 57 Minutes long; and then the S. by E. Line, 83 Minutes long, ending in C, the Place where the Ship now is.

Laſtly, Draw a Line from C to A (the Place the Ship departed from) and from C let fall the Perpendicular BC; then is AC the Ship's Diſtance from the Place of Departure, AB her Difference of Latitude, and BC her Departure from her firſt Meridian, each being meaſured on the ſame Scale the other Lines were taken from, will ſhew how much they are ſeverally, and the Angle BAC meaſured on the Scale of Chords or Rumbs, ſhews her Courſe.

4. Then by Prob. 1. Sect. 3. of this Chap. find the Difference of Latitude and Departure from the Meridian, for thoſe Courſes and Diſtance ſeverally; that is, by the Firſt Caſe of *Plane Sailing*, having the Courſe and Diſtance run given; to find the Difference of Latitude, and the Departure from the Meridian; and that for each given Courſe; which place in their proper Columns, thus; If the Courſe be North Eaſterly, put the Difference of Latitude in the North Column, under *(North)* and the Departure in the Eaſt Column, under *(Eaſt)* if the Courſe be South Eaſterly, then put the Difference of Latitude in the South Column, and the Departure in the Eaſt Column; if South Weſterly, then in the South and Weſt Columns; and if North Weſterly, then in the North and Weſt Columns.

As for Example. The firſt Courſe in the foregoing Traverſe is SE. by S. that is, South Eaſterly; the Difference of Latitude, Minutes 55.7, place in the South Column; and the Departure, Minutes 37.2, put in the Eaſt Column, as in the Table foregoing: The like obſerve for all the reſt.

Note, When the Courſe is E. W. N. or S. then place the Diſtance ſailed in the Eaſt, Weſt, North or South Columns; as here the Fifth Courſe is W. the Diſtance 57 Minutes is placed in the Weſt Column, as you ſee in the Table preceding.

5. Having found the Difference of Latitude, and Departure from the Meridian for each Courſe, and placed them in their proper Columns; add up the North, South, Eaſt, and Weſt Columns ſeverally, and ſubtract the North and South Columns, the one from the other, that is, the leaſt from the greateſt, for the Difference of Latitude; in like Manner, the Eaſt and Weſt Columns for the Departure: As in the foregoing Table, the Sum of the North Column 61.5, ſubtract from the Sum of the South Column 183.7, the Remainder 122.2 is the Difference of Latitude Southerly: And the Sum of the Weſt Column 98.6, ſubtracted from the Sum of the Eaſt Column 138.6, the Remainder 40.0, is the Departure from the Meridian Eaſterly.

6. Then having found the Difference of Latitude, and Departure from the Meridian, the Courſe and Diſtance may be found by Problemn 6. Section 3. of this Chap. And in this Example, the Difference of Latitude being Minutes 122.2 Southerly, and the Departure Minutes 40.0 Eaſterly, the Courſe will be South 18d. 7m. Eaſterly; that is, S. by E. three Quarter E. almoſt, and the Diſtance Minutes 128.6, which was required.

After this manner may you work any Traverſe; and for the Learner's Practice, I ſubjoin the following Examples.

Examp. 2. *Suppoſe in* 24 *Hours a Ship ſaileth as follows*, SW. *by* S. 30 *Minutes*, S. 33. NNW. *half* W. 32. SW. 39. SE. 9. *and* ESE. 11 *Minutes: What is her Difference of Latitude, Departure from the Meridian, direct Courſe and Diſtance?*

Anſw. Difference of Latitude Minutes 67.9 Southerly, Departure Minutes 42.8 weſterly, Courſe is South 32d. 13m. weſterly, or SW. by S. neareſt, Diſtance Minutes 80.26 Hundred.

Examp. 3. *If a Ship ſaileth (by the Log Board) in* 24 *Hours as follows* NNE. 83 *Min.* SW. 74. E. *by* S. 92. NNW. 126. S. *by* W. 47. *and* NE. *by* N. 78 *Minutes: What is her Difference of Latitude, Departure, directed Courſe, and Diſtance run.*

Anſ. Difference of Latitude Minutes 141.7 Notherly, Departure Minutes 55.6 Eaſterly, Courſe is North 21d. 25m. Eaſterly, or NNE. neareſt, Diſtance Minutes 152.3.

Example 4. *If a Ship ſaileth* W. *by* S 87 *Min.* N. 46. SSE. 75. E. 83. NW. *by* W. 79. NE. *by* E. 57. *and* NW. *by* N. 64 *Min. I demand her Difference of Latitude, Departure, direct Courſe, and Diſtance run?*

Anſw. The Difference of Latitude Minutes 88.6 Notherly, Departure Minutes 27.5 weſterly, Courſe North 17d. 15m. weſterly, or N. by W. half W. neareſt, Diſtance 92.68 Minutes.

Examp. 5. *A Ship ſaileth as follows, NNE. 55 min. NW.* $\frac{3}{4}$*W.* 96. *S. by E.* $\frac{1}{4}$ *E.* 57. *WSW.* $\frac{1}{2}$ *W.* 89. *NE. by N.* $\frac{3}{4}$ *E.* 100. *SW by W.* $\frac{1}{4}$ *W.*54. *and N. by E.* 50. *min. What is her Difference of Latitude, Departure, direct Courſe aod Diſtance run?*

Anſw. Difference of Latitude [illegible]. 131.8. Northerly, Departure minutes 92.1 Weſterly, Courſe 34d. 56m. North Weſterly, or NW. by N. neareſt, Diſtance 160.7 Minutes.

Examp. 6. *A Ship in* 46*d.* 24*m. South Latitude, ſaileth by the Log-board in* 24 *Hours SE.* 8 *min. SW by W.* $\frac{1}{2}$ *W.* 6. *NE by E.* 5. *WNW.* [illegible] *W.* 9. *NW.* 4. *ESE.* $\frac{1}{4}$ *E.* 3. *S. by E.* 7. *NNE.* $\frac{1}{2}$ *E.* 4. *and E.* 7 *min. What is her Difference of Latitude, Departure, direct Courſe, Diſtance run, and Latitude ſhe is in?*

Anſw. Difference of Latitude min 4.62 Southerly, Departure min 6.17 Eaſterly, Courſe is S. 53d. 10m. Eaſterly, or SE $\frac{3}{4}$ E. Diſtance Run min. 7.71, and Latitude in 46d. 29m. South.

Example 7. *Admit a Ship in* 1*d.* 30*m. North Latitude, ſails NNE.* 6 *min. SE by S.* $\frac{1}{2}$ *E.* 5. *NE by E. half E.* 4. *WNW.* $\frac{3}{4}$ *W.* 8. *SW by S. half W.* 7. *NW by N.* 4. *ENE.* 5. *SW.* 7. *and SE by E.* 5 *min. I demand her Difference of Latitude, Departure, direct Courſe, Diſtance Run, and what Latitude ſhe is in?*

Anſw. Difference of Latitude minutes 2.40 Southerly, Departure min. 1.59 Weſterly, Courſe is South 33d. 31m. Weſterly, or SW by S. Diſtance minutes 2.88, and Latitude ſhe is in 1d. 28m North.

Thus much for the Second Part of *Plane Sailing*, called a *Traverſe*, we go on to the Uſe of an *Oblique Triangle* in *Plane Sailing.*

Sect. V. *Plane Sailing the third Part, or the Doctrine of Oblique Plane Triangles applied in Problems of Sailing by the* Plane Chart.

ALtho' this Part of Plane Sailing is the leaſt uſeful, and moſt difficult: yet for the Learner's Diverſion I will add ſome Problems.

Prob. I. *Suppoſe two Ports lie North and South, and a Ship ſails from the Nothermoſt* SE. 68 *Min. another from the Southermoſt ſails* NE. *by* N. *till ſhe meets the firſt Ship; I demand the Diſtance of theſe Ports, and the ſecond Ship's Diſtance run?*

In the Oblique Triangle ADE, *Plate* 3. *Fig.* 1.

Let A repreſent the Nothermoſt } Port.
D the Southermoſt ——— }

The Side { AE the firſt——— } Ship's Courſe aud Diſtance.
{ DE the ſecond——— }

E the Place where the two Ships meet.

Here are two Angles and one Side oppoſite given, and therefore by Chap. 2. Sect. 3. Prob. 5. Caſe 1. of *Oblique-angles*, in Page 44.

1. For the Side AD, the Diſtance of the two Ports, the Proportion by *Axiom* the 2d, is,

S. A D E .. Side AE : : S. A E D .. Side AD.
S. 3 Points .. 68 Min. : : S. 9 Points .. Min. 120.

Note; When an Angle exceeds 8 Points, ſubtract it from 16; as here, 9 Points being ſubtracted from 16, the Remainder 7 Points, is to be uſed inſtead of it.

2. For the Side DE, the ſecond Ship's Diſtance, the Proportion by the ſaid *Axiom*, is,

S. A D E .. Side AE : : S. D A E .. Side DE,
S. 3 Points .. 68 Min. : : S. 4 Points .. 86. 55 Tenths.

Prob. II. *Suppoſe two Ports lie* NE. *and* SW. *and a Ship ſails from the Southermoſt* ESE. 45 *min. another from the Northermoſt runs* 72 *min. and then meets the firſt Ship; I demand the Courſe ſteer'd by the laſt, and the Diſtance of the Ports?*

In the Oblique Triangle ADE. *Plate* 3. *Fig.* 2.

Let A repreſent of the Southmoſt } Port.
D the Nothermoſt ——— }

The Side { AE the Firſt — } Ship's Courſe and Diſtance.
{ DE the Second }

E the Place where the Ship's meet.

Here are two Sides and one Angle oppoſite given; and by *Chap.* 2. *Sect.* 3. *Prob.* 6. *Caſes* 2 *and* 3. of *Obliqne-Angles* in *Pages* 44 and 45.

1. For the Angle ADE the ſecond Ship's Courſe, the Proportion by *Axiom* the 2d, is,

Side DE .. S. D A E : : Side AE .. S. ADE.
72 Min. .. S. 67d. 30m. : : 45 Min. .. S. 35d. 15m. which ſubtract from SW. 45d. makes the Courſe 9d. 45m. South Weſterly, or S. three quarters Weſt.

2. For the Side A D, the Diſtance of the two Ports, the Proportion by the ſaid *Axiom*, is,

S. D A E .. Side DE. : : S. A E D .. Side AD.
S. 67d. 30m. .. 72 Min. : : S. 77d. 15m. .. 76.01 Minute.

Prob. III. *Two Ships ſail from a certain Road, one ſails* SSE. 50 *Minutes, the other* SSW. 35 *Minutes. I demand their Bearing aud Diſtance?*

In the Oblique Triangle ADE. *Plate* 3. *Fig.* 3.

Let a repreſent the Road.

The Side { AD the firſt — } Ship's Courſe and Diſtance.
{ AE the ſecond }
{ DE the Bearing and Diſtance of the two Ships.

Here

Here are two Sides, and one Angle between them given; and by Chap. 2. Sect 3. Prob. 7. Caſe 4 and 5. of *Oblique-angles*, in Page 45.

1. For the Angles AED, and ADE, by *Axiom* the third.

Side { AD 50 Min. | From the three Angles ——— 180d. 00m.
{ AE 35 Min. | Subtract the Angle DAE——— 45d. 00m.
Sum Sides—85 Min. | Sum of AED, and ADE ——— 135d. 00m.
Diff. Sides—15 Min. | The ½ Sum of AED, and ADE 67d. 30m.
Sum Sides .. Diff. Sides: : T ½ Sum Angles .. T ½ Diff. Angles
85 Minutes :. 15 Min. : : T 67d. 30m. .. T. 23d. 05m.
The half Diff. of the Angles 23d. 05m.

Added, is the greater Angle 90d. 35m. = AED.

Subtracted is the leſſer Angle 44d. 25m. = ADE.

which added to SSE. 22d. 30m. is South Eaſterly 66d. 55m. and North Weſterly 66 deg. 55m. that is ESE. and WNW. neareſt, is the Bearing of the two Ships.

2. For the Side DE, their Diſtance, the Proportion by the 2d *Axiom.*

S.ADE .. Side AE : : S. DAE .. Side DE required.
S. 54d. 25m. .. 35 Min. : : S. 45d. 00m. .. Min 35.36 Hundreds.

Prob. IV. *Suppoſe a Ship ſaels* N. E. 50 *Leagues, then South Eaſterly* 85 *Leagues; and then forced back by foul Weather* 105 *Leagues to tho Place from whence ſhe firſt ſailed: I demand her ſecond Courſe, and her laſt Courſe back?*

In the Oblique Triangle ADE, *Plate* 3. *Fig.* 4.
Let A repreſent the Place ſailed from at firſt.
D } the { ſecond Place, and Side DE the 2d Courſe and Diſt.
E } the { third Place, and Side EA the 3d Courſe and Diſt.

Here are three Sides given; and by Chap. 2. Sect. 3 Prob. 8. Caſe 6. of *Oblique-angles*, in Pages 46 and 47.

1. For FE the Difference of the Segments AB and BE; the Proportion according to the 4th *Axiom*, is,

Leagues,
Side { DE 85 | S.AE .. *Sum* DE&DA : : *dif.* DE&DA .. FE *diff.Seg*
{ DA 50 | 105 *Leag.* .. 135 *Leagues* : : 35 *Leagues* .. 45 *Leag.*
Sum ——— 135 | 45 FE Difference of the Segments AB, and BE.
Diff.——— 35 | 150 } the half is { 75 BE the greater Segment.
60 } the half is { 30 AB the leſſer Segment.

Side AE ——— 105 Leagues

2. For the Angles DAE and AED, the Proportion by the firſt Axiom, is,
Hypotenuſe AD ·· Radius : : Leg AB ·· S.c. DAB or DAE.
50 Leagues ·· S. 90d. : : 30Leag. .. S. 36d. 52m.
Subtract from ——— ——— 90d. 00m.

Reſteth Angle DAE ——— 53d. 08m. which being added to the NE. makes N. Eaſterly 98d. 08m. or South Eaſterly 81d. 52m. ſo that the Courſe from E to A, is W. by N. a quarter W. back to the Place firſt ſailed from. And again;
Hypotenuſe DE ·· Radius : : Leg BE ·· S.c. BED, or AED.
85 Leagues ·· S. 90d. : : 75 Leag. ·· S. 61d. 55m.
Subtract from ——— 90d. 00m.

Reſteth the Angle AED ——— 28d. 05m.
Which ſubtract from the South Eaſterly 81d. 52m. leaveth 53d. 47m. or SE. three quarters E. neareſt, for the ſecond Ship's Courſe from D to E.

Theſe are the Kinds of Oblique Queſtions, tho' Multitudes may be propoſed, of which here followeth a Taſte, to exerciſe the Young Learner; all of them to be reſolved by the foregoing.

Prob. V. *Suppoſe a Merchant-man in* 45d. 30m. North Latitude, *falls into the Hands of Pyrates, who take away his Sea Compaſs; after which he ſaileth as directly as he can* 67 *Leagues between the South and Weſt, and at the End of two Days meets a Ship of War, who alſo had been the Day before in* 45d. 30m. North Latitude, *and had ſailed thence* SE. *by* S. 39 Leagues; *now the Merchant-man left thoſe Pyrates lying too and fro where they robbed him, and the Man of War being deſirous to find them; I demand what Courſe he muſt ſhape to ſpeak with them?*

Anſw. North 61d. 3m. Eaſterly, or NE. by E. half E. the Man of War muſt ſteer to find the Pyrate.

For this Problem is an Oblique Triangle; two Sides and one Angle oppoſite given, to find the Angle oppoſite to the other Side; which Triangle is thus made.

1. Deſcribe a Circle with the Chord of 60 Degrees, and quarter it, on whoſe Diameter ſet N.E.S.W. and A at the Center; but (always) N. at the upper Part, and E. at the Right-hand of the Circle.

2. Then lay 3 Points from S. towards E. on the Circle, and draw the SE. by S. Line, (AD) 39 Leagues long.

3. With 67 Leagues, and one Foot on D, with the other croſs the Line WAE (produced to the Eaſtward) in C, the Place where the Ship fell in with the Pyrates.

4. Then draw a Line from C to D, and it's done: For A and C are both in the Latitude of 45d. 30m. and the ſide AD repreſents the Man of War's Courſe and Diſtance, and the Side CD the Merchant Man's after he loſt his Compaſs, ſo that the Angle ACD being meaſured on the Scale of Chords, will ſhew her Courſe from the Weſt, towards the South, the Complement of the oppoſite Point thereof is the Man of War's Courſe North Eaſterly, to find the Pyrates.

Problem VI. *Coaſting along Shore, I ſaw two Capes of Land; the firſt did (by the Compaſs) bear* N. *the ſecond* WNW. *then I ſtood away* NW. *by* N. 9 *Minutes, until the firſt bore from me* E. *by* S. *and the ſecond* S. *by* E. *the Bearing and Diſtance of them is required?*

Anſw. South 37d. 58m. Weſterly, or SW. by S. half W. and NE. by N. half E. neareſt, Diſtance Minutes 6.221 Parts of a Thouſand.

Note, In all Queſtions of this Nature, you muſt, as preparative Work, find the Diſtance of each Cape from the Ship, either at firſt ſetting, or at laſt ſetting; which is evident by the Proection, thus;

1. Having drawn a Circle, quarter'd it, and placed the Letters N, S, E, W, and A; as directed in the laſt Problem, produce AN up higher, becauſe the firſt Cape's Bearing is North.

2. Lay 6 Points from N, towards W, and draw the WNW. Line, for the Second Cape's Bearing.

2. Lay 3 Points from N, towards W, and draw the NW. by N. Line 9 Minutes long, from A to D, the Ship's Courſe and Diſtance.

4. Then lay 7 Points from S, towards E, and laying a Scale on it and A, draw an E. by S. Line from D, Parallel to the Edge of the Scale, to cut the North Line in B, the firſt Cape.

5. In like manner, lay 1 Point from S, towards E, and lay a Scale on it, and A, draw a S. by E. Line from D, Parallel to the Edge of the Scale, to cut the WNW. Line in C, the ſecond Cape.

6. Draw a Line from B to C, and its done. For the Line BC repreſents the Bearing and Diſtance of the two Capes, from each other, which being meaſured on the ſame Scale, the Side AD was t[illegible] from, will ſhew their Diſtance aſunder. And the

Angle ABC, meaſured on the *Scale of Chords or Rumbs*, will ſhew their Bearing, which is South Weſterly, and North Eaſterly.

But to find theſe Things by Trigonometry, it's neceſſary to find the Sides AB and AC; or elſe the Sides DB and DC; which is done in Two Oblique Triangles ABD, and ACD, in each, all the Angles, and one ſide is given, to find a Side.

And Note, A repreſents the Place of the Ship at firſt ſeeing the Capes, and D the Place at laſt Sight, or ſetting them.

So that, when the Sides AB and AC, or DB and DC, are found; then there is either the Oblique Triangle BAC, or BDC to work in; then BC (the Side common to both Triangles) with its adjacent Angles may be found, by which their Bearings and Diſtances from each other are diſcovered: And in each Triangle there are two Sides and one Angle between them given, to find the other Angles, and third Side; which is to be wrought as the third Problem of this Section.

Prob. VII. *Suppoſe a Ship ſailing* NW. *two Iſlands appear in Sight, one bears* WNW. *tho other* N. *from the Ship, and when the Ship hath ſailed* 6 *Minutes further, the firſt bears* W. *by* S. *and the other* NE. *Their Bearing and Diſtance is required.*

Anſ. South 58d. 40m. Weſterly, or SW. by W. a quarter W. and NE. by E. a quarter E. Diſtance is Minutes 9.7 Tenths, found out as before, in the laſt Problem.

Prob. VIII. *Three Ships ſail from one Port, the firſt ſails* SW. *by* W. *the ſecond* W. *by* S. *half* W. *and the third* NW. *by* W. 8 *min. then the firſt bears from the third* S. *by* W. *the ſecond bears from the third* SSE. *The firſt and ſecond Ship's Diſtance ſailed, and their Bearing and Diſtance from each other is required?*

Anſ. Firſt Ship's Diſtance Minutes 10.45, ſecond Diſtance Minutes 4.644, their Bearing North 37d. 15m. Eaſterly, or NE. by N. a quarter E. and SW. by S. a quarter W. Diſtance Minutes 6.719. This alſo is wroght by the Direction of the 6th Problem.

Problem IX. *Admit ſailing along Shore, I ſee two Headlands, the Eaſtermoſt bears* NNE. *and the Weſtermoſt* NW. *off me, at the ſame time an Iſland bears* S. *then after I ſailed* W. 8 *Minutes the firſt did bear* NE *by* E. *half* E. *the ſecond* NNE. *and the Iſland* ESE. *from me: The Bearing and Diſtance of theſe Places from each other is required?*

Anſw. The Head-lands bear North 88d. 48m. Weſterly, or

Eaſt and Weſt neareſt, Diſtance Minutes 7.934. The Eaſtermoſt Head-land bears from the Iſland, North 14d. 29m. Eaſt, or N. by E. a quarter E. and S. by W. a quarter W. Diſtance Minutes 9.095, and the Weſtermoſt Head-land bears from the Iſland, North 32d. 14m. Weſt, or NW. by N. and SE. by S. Diſtance Minutes 10.6 Tenths.

This is of the ſame Nature with the 6th Problem, only here are three Things to be found as preparative, *viz.* the Diſtance of each Head-land, and the Iſland from the Ship, and conſequently to find each of their Bearings and Diſtances, in the three ſeveral Triangles, nine diſtinct Statings and Operations are required.

The next 4 Problems are uſed in turning to Windward.

Problem X. *Suppoſe the Wind* South, *and a Ship is bound to a Port* 400 *Leagues directly to Windward, and makes her way good within* 6 $\frac{3}{4}$ *Points of the Wind. I demand her Diſtance ſailed upon each Tack, to gain the ſaid Port?*

Anſw 822.9 Leagues, is the Ship's Diſtance ſailed on each Tack. It is projected by the Plane Scale, thus;

1. Deſcribe a Circle with a Chord of 60 Degrees, quarter it, and place N.E.S.W. and A, as directed in Problem 5.

2. Lay 400 Leagues on the Meridian, from A (Southerly) to B, the Place the Ship is bound unto.

3. From S. lay 6 $\frac{3}{4}$ Points towards E, and by it from A, draw the ESE. $\frac{3}{4}$ E. Line AC.

4. Alſo lay 6 $\frac{3}{4}$ Points from S, towards W, and laying a Scale on it and A, draw a WSW, $\frac{3}{4}$ W. Line from B, parallel to the edge of the Scale, to cut the ESE. $\frac{3}{4}$ E. Line in C, the Place where the Ship tack'd, and it's done.

For, A repreſents the Place the Ship ſail'd from, B the Port 400 Leagues directly to Windward, A C equal to C B, the Ship's Diſtance ſail'd on each Tack; which being meaſured on the ſame Scale A B was taken from will ſhew how much it is.

But to work it by Trigonometry, in the Oblique Triangle ABC, all the Angles and one Side AB being given, the other Sides AC and CB are found, as in the Firſt Problem of this Section: And becauſe two Angles are equal, the Sides oppoſite to them are alſo equal; therefore one Proportion finds AC equal to CB.

Prob. XI. *The Wind* SW. *and a Ship plying to Windward, (making one or many Boards) hath run* 900 *Leagues; that is,* 450 *with the Larboard Tack aboard, and* 450 *with her Starboard Tack aboard, is got* 300 *Leagues directly to Windward: I demand how near the Wind ſhe makes her Way?*

Anſw. 70d. 32m. or 6 Points and a quarter from the Wind. Which is thus delineated by the *Plane-Scale.*

1. A Circle being deſcribed, quarter'd, and letter'd, as hath been directed in the former Problems; then lay 4 Points, from S, towards W, and by it and A, draw a (SW.) Line 300 Leagues long, from A to B.

2. With 450 Leagues (taken from the ſame Scale AB was taken from) and one Foot on A, make an Arc; alſo with the ſame, and one Foot on B, croſs the former Arc in C.

3. From C, draw Lines to A and B, and it's done; For the Angle BAC, equal to the Angle ABC, meaſured on any Scale of Chords, ſheweth how near the Wind the Ship makes her Way.

But by Trigonometry, thus; In the Triangle ABC, all three Sides are given, to find the Angles which may be done by the Fourth Problem of this Section: But, becauſe the Sides AC and BC are equal, therefore let fall a Perpendicular from C to the SW. Line AB; as AD, which cuts AB in the middle, making AD 150 Leagues equal to BD, and ſo reduces the Oblique Triangle ABC into two equal Right-angled-Triangles, ADC and BDC; whoſe Sides, and Angles in each Triangle are equal to one another; ſo that one Proportion ſerveth to anſwer the Queſtion.

For in the Right-Angled-Triangle ADC, there is given the Hypotenuſe AC 450 Leagues, and Leg AD 150 Leagues; to find the Angle CAD which is equal to the Angle CBD (the Ship's Courſe from the Wind) which is done by Note 2. of Axiom 1. of *Plane Trigonometry,* thus,

Hypot. AC ·· Radius : : Leg AD ·· S. ACD=BCD.
450 Leag. ·· S. 90d. : : 150 Leag. ·· S. 19d. 28m.
Which ſubtract from ———————— 90d. 00m.

Remainder is the Angle CAD = ABC. 70d. 32m. or 6¼ pts. the Ship's Courſe from the Wind SW; that is, her Courſe is SSE. ¼ E. with her Starboard Tacks aboard, and NW. by W. ¾ W. with her Larboard.

Prob. XII. *Admit a Ship bound to a Port that lieth* SW. *by* S. 484 *Leagues Diſtance, the Wind* S. *by* E. *and makes her way good within* 6 $\frac{1}{4}$ *Points of the Wind. I demand how far ſhe muſt ſail upon each Tack, to gain the Port?*

Anſw. 689.8 Leagues on her Larboard Tack, and 326.3 Leagues on her Starboard Tack, to arrive at the Port, which is thus demonſtrated by the Plane Scale.

1. The Circle deſcrib'd, quarter'd, *&c.* as formerly, lay one Point from S, toward E, and by it and A draw a S. by E. Line AB, repreſenting the Wind.

2. From S, towards W, lay 3 Points, and by it and A, draw a SW. by S. Line 484 Leagues long, from A to C.

3. From the Wind (S. by E.) lay 6 $\frac{1}{4}$ Points towards W, and by it and A, draw a (SW. by W. $\frac{1}{4}$ W.) Line AD.

4. Likewiſe lay 6 $\frac{1}{4}$ Points from the Wind (S. by E.) towards E, on which Punct and A, lay a Scale; then from C draw an (E. by S. $\frac{1}{4}$ E) Line to cut the Wind, (S. by E.) Line in B, and the SW. by W. $\frac{1}{4}$ W. Line in D, and it's done: For AD, and DC repreſents the Ship's Diſtance ſailed on each Tack, which being meaſured on the ſame Scale AC was taken from, will ſhew how much the Diſtance ſail'd on each Tack is.

By Trigonometry it's thus; In the Oblique Triangle ACD, all the Angles and one Side is given, to find the other two Sides, which is done by the firſt Problem of this Section, in Page 71.

As S ADC .. Side AC : : S. ACD .. Side AD.

S. 3$\frac{1}{2}$Points .. 484 leag. : : S. 10$\frac{1}{4}$ Points .. 689.8 Leagues, is the Ship's Diſtance ſail'd on her Larboard Tack.

As S. ADC .. Side AC : : S. CAD .. Side CD.

S. 3$\frac{1}{2}$ Points .. 484 leag. : : S. 2 $\frac{1}{4}$ Points .. 326.3 Leagues, is the Ships Diſtance ſail'd on the Starboard Tack.

Prob. XIII. *If two Ports lie* SW. *by* S. *and* NE. *by* N. *Diſtance* 484 *Minutes, the Wind* S. *by* E. *and a Ship ſails from the Northermoſt Port, cloſe upon a Wind* 695 *Minutes, with her Larboard Tack aboard and* 332 *with her Starboard Tack aboard, and then arrives at the Southermoſt Part: I demand how near the Wind ſhe makes her way good upon each Tack*

Anſw. 70d. 32m. on one Tack, and 70d. 31m. on t'other; which is 6 $\frac{1}{4}$ Points from the Wind; that is SW. by W. $\frac{1}{4}$ W. with her Larboard Tack, and E. by S. $\frac{1}{4}$ E. with her Starboard Tack.

Which is thus demonſtrated by the *Plane Scale.*

1. Deſcribe a Circle with a Chord of 60 Degrees, quarter it, *&c.* as formerly, then lay three Points from S, towards W, and by it and A, draw a SW. by S. Line 484 Minutes long, from A to B.

2. Lay 1 Point from S, towards E, and by it and A, draw the S. by E. Line AC.

3. With 695 Minutes (taken from the ſame Scale AB was taken from) and one Foot on A, make an Arc; alſo with 332 Minutes, and one Foot on B, croſs the former Arc in D.

4. From D, draw Lines to A and B, and continue the Line BD, 'till it cuts the S. by E. Line AC in C, and it's done: For the Angles DAC, and ACD meaſured on the Scale of Chords or Rumbs, will ſhew how near the Wind the Ship makes her Way good on each Tack.

By Trigonometry it's thus; in the Oblique Triangle ABD, all the three Sides are given, to find the Angles; that is, the Side AD 695 Minutes, Side AB 484, and Side BD 332; to find the Angles BAD, and BDA; which is done by the Fourth Problem of this Section, in Pages 72 and 73.

The next Problems are concerning Currents

Prob. XIV. *Suppoſe a Current ſets* NNE. 7 *Minutes in a certain Time, and a Ship ſails* SSW. *(by the Log)* 9 *Minutes in the ſame Time: What is her true Courſe and Diſtance?*

Anſw. SSW is the Ship's true Courſe and Diſtance 2 Minutes: which is evident by the Plane Scale, thus;

1. Having done as formerly directed, in making a Circle, *&c.* Lay 2 Points from S, towards W, and by it and A draw a SSW. Line, 9 Minutes long, from A to B.

2. With 7 Minutes (taken from the ſame Scale AB was taken from) and one Foot on B, croſs the Line AB in C, ſo that BC may be NNE. and it's done: For AC meaſured on the ſame Scale, ſheweth the Ship's true Diſtance: Or thus,

From the Ship's ſuppoſed Diſtance SSW. 9 Min. AB.
Subtract the Current's Motion NNE. 7 Min. BC.

Remains the Ship's true Diſtance SSW. 2 Min. AC.

The like is done for the two next following Problems.

Prob. XV. *If a* Current *ſets* E. 4 *Min. an Hour, a Ship ſails* E. *(by the* Log.*)* 5 *Minutes in an Hour: The Ship's true Courſe and Diſtance is required?*

Anſw. The Ship's true Courſe is Eaſt, Diſtance 9 Minutes.

Prob. XVI. *A Current ſetting* WSW. 90 *Minutes in a known time, and a Ship ſailing* ENE. (*by the* Log.) 60 *Minutes in the ſame time: What is her true Courſe and Diſtance.*

Anſw. WSW. 30 Minutes, ſo that ſhe is fallen a Stern.

Prob. XVII. *Suppoſe a Current ſetteth* E. 2 *Minutes an Hour, and a Ship ſails* S. 6 *Minutes an Hour. What's her true Courſe and Diſtance?*

Anſw. South 18d. 26m. Eaſterly, or S. by E. $\frac{3}{4}$ E. is the Ship's true Courſe, Diſtance 6 $\frac{625}{1000}$.

By the *Plane-Scale,* it's thus demonſtrated.

1. After a Circle is deſcribed, *&c.* as formerly, then lay 6 Minutes on the Meridian from A to B.

2. Draw BC parallel to WAE, and thereon lay 2 Minutes from B (towards the Right-hand) to C.

3. Then draw a Line from A to C, and it's done; for the Angle BAC is the Ship's true Courſe, and the Side AC her true Diſtance.

By *Trigonometry* it's thus; The Triangle ABC is a Right-Angled-Triangle, in which both Legs are given, the Leg AB 6 Minutes, the Ship's ſuppoſed Diſtance, and the Leg BC 2 Minutes, the Current's Motion, to find the Angle BAC the Ship's true Courſe, and the Hypotenuſe AC her true Diſtance; which is done by *Axiom the Firſt, and Note* 1, *and* 2, *of Plane Trigonometry, in Page* 36.

In like Manner, *Problem* 18 and 19. are performed.

Prob. XVIII. *If a Ship ſails (five Days together) by the Log,* SW. 725 *Minutes, in a Current that ſetteth (in the ſame time)* SE. 280 *Minutes: What's the true Courſe and Diſtance?*

Anſw. South 23d. 53m. Weſterly, or SSW. is the Ship's true Courſe, Diſtance 777.2 Minutes.

Prob. XIX. *Admit a Ship ſails* W. 730 *Minutes, thwart a Current ſetting to the Southward; and then by Obſervation, findeth the Difference of Latitude is* 4d. *or* 240 *Minutes. I demand her true Courſe and Diſtance?*

Anſw. South 71d. 48m. Weſterly, or WSW. $\frac{1}{4}$ W. is the Ship's true Courſe, Diſtance 768.5 Minutes.

Problem XX. *If a Ship ſails* S. *by* E. 36 *Minutes in a Current, and then arrives at a Port which lieth from the Place ſhe departed from* SE. *by* S. *Diſtance* 54 *Minutes: I demand the Current's Motion both in Quality and Quantity; that is, How it ſetteth, and how faſt?*

Anſwer. The Current ſetteth South 57d. 21m. Eaſt; or ESE. is the Drift of the Current as to Quality, and Minutes 24.9 Tenths is its Drift as to Quantity; and is demonſtrated by the Plane Scale, after this manner;

1. As before, having deſcribed a Circle, *&c.* Lay 1 Point from S. towards E, and by it and A, draw a S. by E. Line 36 Minutes long, from A to B.

2. Lay 3 Points from S, towards E, and by it and A, draw a SE. by S. Line, 54 Minutes long, from A to C.

3. Then draw a Line from B to C, and it's done: For the Angle ACB meaſured (on the Scale) ſheweth the Current's Motion as to its Quality, which Way from the SE. by S. and the Side BC meaſured (on the Scale) ſheweth the Current's Motion, as to its Quantity, how much, or how faſt.

But by *Plane Trigonometry*, 'tis thus,

In the Oblique Triangle ABC, there are given, two Sides, and an included Angle; that is, the Side AC 54 Minutes, the Side AB 36 Minutes, and the Angle BAC two Points, equal to 22d. 30m. to find the Angles ABC, ACB, and the Side BC; which is wrought by *Axiom* the third, and is like the third *Problem* of this Section.

Problem XXI. *Suppoſe a Ship ſails from a certain Cape, or Headland, and (by the* Log) *in* 24 *Hours, runneth* SSW. 49 *Minutes, in a Current ſetting between the* N. *and the* W. *and then the Cape did bear* ENE. *from the Ship, and by Obſervation, the* Difference of Latitude *was* 30 *Minutes; I demand the Current's Motion; that is, upon what Point of the Compaſs, and how faſt?*

Anſwer. The Current ſets North 74d. 7m. Weſt, or WNW. half W. neareſt, and at the Rate of Minutes 2.325 an Hour, and is thus demonſtrated by the Plane Scale,

1. After the Circle is deſcribed, quartered, *&c.* lay two Points from S, towards W, and by it and A, draw a SSW. Line 49 Minutes long, from A to B.

2. Lay 6 Points from S, towards W, and by it and A, draw a WSW. and ENE. Line AC.

3. Lay 30 Minutes (on the Meridian) from A to D, and from D draw a Weſt Line Parallel to AW, to cut the WSW. Line in C.

4. Then draw a Line from B to C, and it's done: For the Angle ABC being meaſured on the Scale, ſheweth the Current's Motion from SSW. and the Side BC being meaſured ſheweth how much the Current ſet the Ship.

By *Plane Trigonometry*, it's thus;

1. In the Right Angle Triangle ADC, there is given the Leg AD 30 Minutes, Angle DAC 6 Points, and Angle ACD 2 Points; to find the Hypotenuſe AC, which is done by *Axiom the firſt, of Plane Trigonometry.*

2. Then in the Oblique Triangle ABC, there is given, the Side AB 49 Minutes, the Side AC found before, and the included Angle BAC 4 Points, equal to 45d. to find the Angle ABC, (the Current's Motion from SSW.) and the Side BC, its Motion how much, which is ſolved by *Axiom* the 3d, as was the laſt *Problem.*

Let this ſuffice for the *Firſt Part of Navigation*, commonly called *Plane-Sailing*, though many more Problems might be invented. *Wright's-Sailing* is next in order.

CHAPTER IV.

The Second Part of Navigation, *or the Doctrine of* Plane Right-Angle-Triangles, *applied in Problems of Mr.* Wright's *Sailing (commonly called)* MERCATOR's SAILING.

IT's neceſſary to deſcribe Mr. *Wright's Chart*, and ſhew the Uſes thereof, before the Problems of Sailing by it, which, by this Method, will be the eaſier underſtood.

Section I. *The Deſcription and Uſe of Mr.* Wright's Chart.

THIS Projection ſuppoſeth the Earth and Sea to make one round Body or Globe: In order to the right underſtanding of which, obſerve the following Definitions.

1. Upon this Earthly Globe are imagined two oppoſite Points, one called the North Pole, the other the South Pole; as P, and I, *Plate* 5. *Fig.* 1.

2. In the Middle between thoſe two Poles, or equally diſtant from each, is drawn a Circle round the Globe, called the

Equator; from which, Latitude taketh its Beginning, and in which, Longitude is reckon'd; as ÆAQ.

3. Any Circle drawn through both Poles, is called a Meridian, as PMI, PNI, *&c.* anſwerable thereunto is any North or South Line drawn in the Chart.

4. Thoſe Circles which are Parallel to the Equator, are called Parallels of Latitude; as *alt*, *Zlt*, *&c.* and are repreſented in the Chart by the Eaſt and Weſt Lines.

5. *Latitude* of a Place, is the (neareſt) Diſtance of any Parallel paſſing over it from the Equator; from thence counted both Ways to each Pole, ending in 90 Degrees, the greateſt Latitude.

6. *North Latitude*, is on that Side the Equator towards the North Pole, and South Latitude on the other Side of the Equator, towards the South Pole.

7. *Difference of Latitude*, is the (neareſt) Diſtance between any two Parallels, and ſheweth how far one Place is to the Northward or Southward of another, it never exceeds 180 Degrees.

8. *Longitude*, is reckon'd in the Equator, round which (by ſome) it's counted increaſing to the Eaſtward, 'till it end (where it firſt began) in 360 Degrees, the greateſt Longitude: Others (as Mr. *Wakely*, in his *Mariner's Compaſs Rectified*, and alſo now in the *Mariner's New Calendar*) reckon it from one Meridian, both Eaſterly and Weſterly, till both Accounts meet at 180 Degrees in the oppoſite Meridian, as in both the aforeſaid Books, Longitude begins at the Meridian of *London*, and from thence is counted Eaſterly, Eaſt Longitude 180 Degrees; and Weſterly, Weſt Longitude 180 Degrees, at which both Longitudes end.

9. *Difference of Longitude*, is that Diſtance or Portion of the Equator contained between the Meridians of any two Places, and ſheweth (in the Equator) how far the Meridian of one Place, is to the Eaſtward or Weſtward of the Meridian of another, and never exceeds 180 Degrees.

From theſe Definitions, or Principles, there muſt neceſſarily follow theſe *Theorems*.

1. *The Diſtance of any Two Meridians*, in any Parallel of Latitude, is leſs than their Diſtance in the Equator, becauſe all Meridians on the Globe meet in the Poles.

2. The Degrees of Longitude diminiſh towards each Pole; and the nearer the Pole, the leſs they are, becauſe the Meridians approach nearer to one another, the farther you ſail from the Equator, towards either Pole.

3. The Degrees of Latitude are equal in all Places or Parts of the Globe.

4. The Plane Chart, which counteth the Degrees (as well of Longitude, as of Latitude) in all Places, to be equal, is notoriouſly Falſe.

5. Mr. *Wright*'s Projection (commonly known by the Name of *Mercator's-Chart)* wherein (though the Degrees of Longitude are equal, having the Meridians Parallel to one another) the Degrees of Latitude are enlarged towards each Pole, in the ſame Proportion as the Degrees of Longitude diminiſh on the Globe, will in all Reſpects agree with the Globe, and is a true Way of Sailing.

Theſe *Definitions* and *Theorems* duly conſider'd, there needs no further Deſcription of this Chart, it having only this Difference from the Plane Chart, before deſcribed in *Chap.* 3. *Sect.* 2. *Page* 53. that the Equator is divided and numbered in Degrees, as the graduated Meridian is in the other: the Uſes are as follow.

Problem I. *To find the Latitude of any Place in the Chart.*

This was taught before (in the Uſe of the *Plane Chart)* in Page 54, and needs no further Rule or Example.

Problem II. *To find the Longitude of any Place in the Chart?*

The Rule. 1. Take the neareſt Diſtance from the propoſed Place, to any Meridian.

2. Move the Compaſſes (being kept at that Diſtance with one Foot on the Meridian) 'till both Feet come to the Equator, and the Foot which ſtood on the propoſed Place ſheweth its Longitude required.

Example. *I demand the Longitude of the* Lizard *in* England?

Anſw. 9d. 42m. according to the old Way of computing the Longitude from the Meridian of *Pico Teneriff*; But 5d. 14m. Weſt Longitude, counting Eaſt and Weſt Longitude from the Meridian of *London*, according to the *Mariner's Compaſs Rectified.*

Note, Some Charts begin Longitude at the *Lizard*, counting from thence Eaſtward and Weſtward, 180 Degrees.

Problem III. *To find the Courſe or Bearing of any two Places in the Chart.*

This is done as before, in the Uſe of the Plane Chart, in page 55, and needs no Example.

Problem IV. *To find the Diſtance of any two Places in the* Chart.

In this Problem are four Caſes; the two Places may be ſituated under one Meridian, under the Equator, or in one Parallel, or they may differ both in Latitude and Longitude.

Caſe 1. *Two Places under one Meridian, (that is, differing only in Latitude) being given, to find their Diſtance.*

The Rule. Find the Difference of Latitude between the two given Places, and 'tis the Diſtance required.

How to find the Difference of Latitude between the two Places, has been taught in *Chap.* 3. *Sect.* 3. of *Plane Sailing*, in page 58.

Caſe 2. *Two Places in the Equator given, to find their Diſtance.*

The Rule. Find the Difference of Longitude between them, and 'tis the Diſtance required.

How to find the Difference of Longitude, will be ſhewed in the next *Section*, in page 89.

Caſe 3. *Two Places in one Parallel, (that is, differing only in Longitude) being given, to find their Diſtance.*

The Rule 1. Take the Diſtance between the given Places in the Compaſſes.

2. Lay that Diſtance on the graduated Meridian, ſo that one Foot may be as many Degrees above the Parallel of the given Places, as the other below it, there ſtay the Compaſſes.

3. Count the Degrees between the Feet of the Compaſſes, and 'tis the Diſtance required.

Example. *I demand the Diſtance from the* Lizard *in* England, *to* Pengwin Iſland *on the Coaſt of* Newfoundland, *both being nearly in the Latitude of* 50d. 00m. *North.*

Here, the Diſtance from the *Lizard* to *Pengwin* Iſland applied to the Meridian as directed, will reach from 31d. 30m. to 62d. 00m. the latter being as much above 50d. 00m. as the former is below it; and the Degrees intercepted are 30½, or 610 Leag. which is the Diſtance required.

Take the Length of the Degree in the given Latitude, as here from 49d. 30m. to 50d. 30m. turn that over in a ſtrait Line, from the *Lizard* to *Pengwin* Iſland, and it's 30½ Times; which ſhews the Diſtance 30d. 30m. as before.

Caſe 4. *Two Places differing in Latitude and Longitude, being given, to find their Diſtance.*

The Rule. 1. Take their Difference of Latitude from the Equator.

2. Lay a Ruler on both given Places, apply that Diſtance ſo to the Ruler's Edge, that when one Foot is placed cloſe to the Ruler, and the other turned about, it may juſt touch ſome Eaſt and Weſt Line, croſſed by the ſaid Ruler's Edge, there ſtay the Compaſſes.

3. Then the Diſtance (by the Ruler's Edge) from the Place where the Compaſſes reſted, to that Place where the Ruler croſſeth the aforeſaid Eaſt and Weſt Line, meaſured on the Equator, giveth the Diſtance required.

Example.

I demand the Diſtance from the Lizard, *to the Iſland* Barbadoes?

The *Lizard*'s Latitude is —— 49d. 57m. } by *Problem* 1.
And *Barbadoes* Latitude is —— 12d. 58m. }

Their Difference of Latitude—36d. 59m.

Then take their Difference of Latitude 36d. 59m. from the Equator, and laying a Ruler on both Places, apply one Foot of the Compaſſes ſo to the Ruler's Edge, that turning the other about, it may touch an Eaſt and Weſt Line, croſſed by the Ruler; then the Diſtance (by the Ruler's Edge) from the Place where the Compaſſes reſted, to the Place where the Ruler croſſed the aforeſaid Eaſt and Weſt Line, meaſured on the Equator, is 57d. 45m. or 1155 Leagues, the Diſtance required.

And here obſerve; the Meridian Line, and Line of Equal Parts next one to another on the *Gunter*'s Scale, the firſt repreſents the Meridian Line, and Degrees of Latitude in a *Mercator*'s Chart; the latter the Equator-Line, and Degrees of Longitude.

Thus much for the Uſe of *Mercator's-Chart*, Problems of ailing thereby are next; but firſt ſome preparatory Problems in *Geography*.

Section II. *Some neceſſary Geographic Problems uſeful in* Mercator's-Sailing.

THESE Problems properly belong to *Geography*, but are neceſſary in ſailing by Mr. *Wright*'s (commonly called *Mercator*'s) Chart, and for that Reaſon are placed here.

Note, That all the Places mentioned in this Book, their Latitudes and Longitudes were taken from a Chart, Intitled, *A new and exact Chart, containing the Sea-Coaſt of* Europe, Africa, *and* America; *from* England *to* Cape Bona Eſperance, *and from* Newfoundland *to the* Straits *of* Magellan, *according to Mr.* Edward Wright's *Projection, and Publiſhed by* W. *and* J. Mount, T. Page, *and* Son, *on* Tower-Hill.

This Chart has been new made, and lately corrected, wherein the Longitude of Places is reckoned from the Meridian of *London*, agreeing with the *Mariner's Compaſs Rectified*: As for the Diſagreement that may be found between it and Tables of Latitude and Longitude in other Books, 'tis not to be regarded; becauſe the Tables themſelves conſiderably differ one from another, the Longitude being taken from different Meridians, or differently counted, as may appear by the following Problems.

Problem I. The Latitudes of two Places given; to find their Difference of Latitude.

Rule 1. If the two Places are upon the ſame Side of the Equator, that is, both in North Latitude; or both in South Latitude; ſubtract the leſs Latitude from the greater, the Remainder is the Difference of Latitude.

Rule 2. If one Place be on one Side of the Equator, and the other Place on t'other Side; that is, one Place in North Latitude, the other in South; add the two Latitudes together, and the Sum is the Difference of Latitude.

Obſerve 1. If a Ship ſails from a great North Latitude to a leſs, ſhe ſails Southerly; and if a Ship ſails from a leſs North Latitude to a greater, ſhe ſails Northerly, which is called raiſing the Pole.

2. If a Ship ſails from a great South Latitude to a leſs, ſhe ſails Northerly; but if ſhe ſails from a leſs South Latitude to a greater, ſhe ſails Southerly.

3. When a Ship croſſes the Equator, and ſails from North Latitude into South, the Difference of Latitude is Southerly; or if ſhe ſails from South Latitude into North, ſhe ſails Northerly.

Example 1. *I demand the Difference of Latitude between the* Lizard, *and* Iſland Barbadoes.

The *Lizard*	Latitude	49d. 57m.	North
I. *Barbadoes*		12d. 58m.	

Their Diff. of Latitude by Subtraction is 36d. 59m. equal to 2219 Minutes.

Example 2. *To find the Difference of Latitude between the* Iſland Barbadoes *and* Iſland *St.* Helena-Nova.

Iſland *Barbadoes*	in Latitude	12d. 58m.	North.
St. *Helena*		16d. 00m.	South.

Their Diff. of Latitude by adding, is 28d. 58m. equal to 1738 Minutes.

Problem II. *The Latitude of one Place, and the Difference of Latitude between that and another Place being given, to find the Latitude of the latter Place, or Latitude the Ship is in?*

The Rule.

The Latitude, and Difference of Latitude given, being of
One } Name their { Sum } is the Latitude required.
a contrary } Name their { Diff. } is the Latitude required.

Or thus, in two Rules.

Rule 1. In { North / South } Lat. ſailing to the { North / South } ward, add the Difference of Latitude to the given Latitude, the Sum is the Latitude required, of the ſame Name.

Rule 2. In { North / South } Lat. ſailing to the { South / North } ward, ſubtract the leſs from the greater, the Remainder is the required Latitude of the ſame Name with the greater.

Example 1. Sailing from the *Iſland Barbadoes* North Eaſtward, ntil the Difference of Latitude be 372 Leagues; What Latitude s the Ship in?

I. *Barbadoes*, Latitude is ———— 12d. 58m. North.
The Difference of Lat. 372 Leag. or 18d. 36m. Northerly.

Add, is the Latitude the Ship is in — 31d. 34m. North.

Example 2. From the *Lizard*, a Ship ſails South Weſtward, until the Difference of Latitude be 137 Leagues; What Latitude is the Ship in?

The *Lizard*, Latitude is ———— 49d. 57m. North.
The Difference of Lat. 137 Leag. or 6d. 51m. Southerly.

The Lat. the Ship is in by Sub. is —— 43d. 06m. North.

Example 3. From St. *Helena-Nova* a Ship ſails North Weſtward until the Difference of Latitude be 419 Leagues; What Latitude is the Ship in?

I. St. *Helena*, Latitude is ———— 16d. 00m. South.
The Difference of Lat. 419 Leag. or 20d. 57m. Northerly.

Latitude the Ship is in ———— 4d. 57m. North.

Problem III. *The Longitude of two Places given; to find their Difference of Longitude.*

1. ACcording to the old Way of counting the Longitude, The Rule is thus,

Subtract the leſs Longitude from the greater, the Remainder (if leſs than 180 Degrees) is the Difference of Longitude; but if the Remainder be more than 180 Degrees, ſubtract it from 360 Degrees, the laſt Remainder is the Difference of Longitude.

2. According to the new Way of counting of Longitude, in the *Mariner's Compaſs Rectified*, the Rule is thus;

If both Longitudes be Eaſt or both Weſt, ſubtract the leſs from the greater, the Remainder is the Difference of Longitude; but if one be Eaſt, and the other Weſt, add them together, and the Sum (if it exceed not 180 Degrees) is the Difference of Longitude; and when the Sum doth exceed 180 Degrees, ſubtract it from 360 Degrees, the Remainder is the Difference of Longitude required.

Bxample

Example 1. *I demand the Difference of Longitude, between the* Lizard *and Iſland* Teneriff, *one of the* Canary Iſlands?

		d. m.
According to the old Account, Long. of	*Lizard* is	9 42
	I. *Teneriff*	0 00
Their Difference of Longitude by Subtracting is ——		9 42
According to the *Mar. Compaſs*, Lon. of	*Lizard* is	5 14W.
	I. *Teneriff*	16 28W.
Their Difference of Longitude by Subtraction is ——		11 14W.

Their Difference of Longitude between theſe two Places, are very different in ſeveral Books, therefore all in this Book are taken from the *Chart* aforeſaid, or from the *Mariner's Compaſs Rectified.*

Example 2. *What's the Difference of Longitude between the* Lizard, *and* I. Barbadoes?

By the *Mariner's Compaſs* Longit. of	*Lizard* is —	5d. 14m.W.
	I. Barbadoes	58d. 50m.W.
Subtract, is the Difference of Longitude ———		53d. 36m.

equal to 3216 Minutes.

Problem IV. *To know when the Difference of Longitude between any two Places, is Eaſterly, or Weſterly.*

1. ACcording to the old Way of counting the Longitude, the Rule is thus;

If the Remainder (firſt found) be leſs than 180 Degrees, and you are bound to that Place, which hath (of the two) the greater Longitude, then is the Difference of Longitude Eaſterly; but if you are to ſail to the leſs, it's Weſterly: And when the firſt Remainder is more than 180 Degrees, it's juſt the contrary.

2. According to the *Mariner's Compaſs Rectified*, The Rule is thus;

When the Longitude of the two Places are both Eaſt or both Weſt, and you are to ſail to the greater Longitude; then the Difference of Longitude is (according to the Name of the Longitude) Eaſt or Weſt: But if bound to the leſs Longitude, then is the Difference of Longitude contrary, that is, Weſt in Eaſt Longitude, and Eaſt in Weſt Longitude: And if one Place lies in Eaſt Longitude, and t'other in Weſt, the Difference of Longitude between them, is according to the Name of that Longitude you are bound unto, that is, Eaſt, if to Eaſt Longitude; and Weſt, if to Weſt Longitude.

Prob.

oblem V. *The Longitude of one Place, and the Difference of Longitude between that and another Place, being given; to find the Longitude of the laſt Place, or the Longitude the Ship is in.*

ACcording to the old Way of counting the Longitude, the Rules are theſe following.

Rule 1. Sailing to the Eaſtward, add the Longitude, and the ifference of Longitude together, the Sum, (but if it exceeds 60 Degrees ſubtract 360 Degrees therefrom, the Remainder) is e Longitude the Ship is in.

Rule 2. Sailing to the Weſtward, Subtract the Difference of ongitude, from (but if the Difference of Longitude be the reateſt, add 360 Degrees to) the Longitude of the firſt Place, e Remainder is the Longitude the Ship is in.

2*dly*, According to the new Way of counting the Longitude in e *Mariner's Compaſs*; the Rules are theſe;

Rule 1. In Eaſt Longitude, ſailing to the Eaſtward, and in Veſt Longitude, ſailing Weſterly, add, gives the Longitude the ip is in, (if it exceeds not 180 Degrees) agreeing with the ame of the firſt Place; but if it doth exceed, ſubtract it from 60 Degrees, the Remainder is the Longitude the Ship is in, of contrary Name to the firſt.

Rule 2. In Eaſt Longitude, ſailing Weſterly, and in Weſt ongitude, ſailing Eaſterly, ſubtract, gives the Longitude the hip is in, whoſe Name agrees with the greater.

xample 1. Sailing from *Barbadoes* North Eaſterly, 'till the Difference of Longitude be 275 Leagues, What Longitude is the Ship in?
d. m.
y the *Mariner's Compaſs*, Long. of the I. *Barbadoes* is 58 50 W.
he Difference of Longitude is 275 Leagues, or — 13 45 E.
ubtract, gives the Longitude the Ship is in ——— 45 05 W.

Example 2. From the *Lizard* a Ship ſails S. Weſterly, 'till the ifference of Long. be 352 Leag. What Longitude is the Ship in?
d. m.
y the *Mariner's Compaſs*, Longitude of the *Lizard* is 05 14 W.
he Difference of Longitude is 352 Leagues ——— 17 36 W.
dd, gives the Longitude the Ship is in ——— 22 50 W.

Thus much for the Preparation to Sailing by this Chart, the roblems are next.

Sect.

Sect. III. *Containing Problems of Sailing by Mr.* Wright's Chart, *commonly called* Mercator's-*Sailing.*

IN the Working of theſe Problems, a Table of Meridional Parts is neceſſary; accordingly out of Mr. *Wright's* Table, I have drawn one to every fifth Minute of Latitude, countin the Meridional Parts in Miles, or Minutes of the Equator: Se Pages 304, and 305, for their Uſe; which Tables you will fin placed before the Table of Logarithms, whoſe Uſe is to find th Meridional Difference of Latitude, between any two given Latitudes, and that is done by the next Problem.

Problem I. *To find the Meridional Difference of Latitude, or the Difference of Latitude in Meridional Parts.*

The Rule is,

The Latitudes of { one —— / a contrary } Name, the { Diff. / Sum } of th Meridional Parts, (found in the Table of Meridional Parts) anſwering to the Degrees and Minutes of each Places Latitude, i the Meridional Difference of Latitude required.

Example 1. Iſland Barbadoes, *and St.* Thomas, *an Iſland on th Coaſt of* Gabon *in* Africa; *What is the Meridional Difference o Latitude?*

Minu

Iſland { *Barbadoes* / St. *Thomas* } Lat. { 12d. 58m.N. / 00d. 00m. } Mer. Pts. { 785 / 00

Meridional Difference of Latitude ———————— 785

Example 2. *The* Lizard *and* Iſland Barbadoes; *What is thei Meridional Difference of Latitude?*

Min

Lizard / I. *Barbadoes* } Latitude { 49d. 57m. / 12d. 58m. } N. Merid. Parts { 347 / 785

Subtract, gives the Meridional Difference of Latitude —— 2685

Exampl

Example 3. Iſland Barbadoes, *and* Iſland *St.* Helena; *What is their Meridional Difference of Latitude?*

					Min.
ſland	*Barbadoes*	Lat.	12d. 58m. N.	Merid. Parts	785
	St. *Helena*		16d. 00m. S.		973

Add, gives the Meridional Difference of Latitude —— 1758

Problem II. *The Latitude and Longitude of two Places given; to find the Courſe and Diſtance?*

Example. *What is the Courſe and Diſtance from the* Lizard *to the* Iſland Barbadoes?

		d. m.		Min.		d. m.
Lizard	Lat.	49.57N.	Mer. Pts.	3470	Lon.	5.14W
I.*Barb.*		12.58N.		785		58.50W
Diff. of Lat. ——		36.59S.	Mer. Diff. Lat.	2685	Diff. Lon.	53.36W
		60				60
		or 2219 Min.				or 3216 Min.

This Rectangle Triangle ABC (*Plate* 3. *Fig.* 5.) is made by *Problem* 13. of *Practical Geometry*, after this manner.

1. From A repreſenting the Place ſailed from, lay the Meridional Difference of Latitude to B.

2. Draw BC perpendicular to AB, and thereon lay the Difference of Longitude, from B to C.

3. From A to C (repreſenting the Place the Ship is bound to) draw a Line, which concludes the Triangle ABC, Right-angled at B, whoſe Angle BAC meaſured on the Scale of Chords or Rhumbs, ſhews the Courſe, or Bearing of the two Places.

4. Take the Difference of Latitude, and lay it on the Meridian, from A to D, and draw a Line DE, parallel to BC, to cut AC in E, and it's done: For if AE be meaſured on the ſame Scale AD was taken from, it ſheweth the Diſtance between the two Places.

But to reſolve it by *Trigonometry*, there are two Rectangle

Triangles ABC, and ADE; in the former you muſt *Note*,

1. The Leg AB, is the Meridional Difference of Latitude.
2. The Leg BC, is the Difference of Longitude.
3. The Angle BAC, is the Courſe or Bearing.
4. The Angle ACB, is the Complement of the Courſe.

Secondly, In the Rectangle Triangle ADE.

1. The Leg AD is the proper Difference of Latitude.
2. The Hypotenuſe AE, is the Diſtance of the two Places.
3. The Leg DE, is the Departure from the Meridian.
4. The Angle DAE, is the Courſe, or Bearing.
5. The Angle AED, is the Complement of the Courſe.

Theſe Things being premiſed, the Proportions according to *Axiom* 1. *Note* 2, of Plane Right-Angled Triangles, are as followeth:

1. For the Courſe, the Proportion by *Axiom* 1. *Note 2d*, is this:

If the Leg AB is made Radius, then the Leg BC is the Tangent of the Angle BAC, and therefore it is,

As the Meridional Difference of Latitude, is to the Radius; ſo is the Difference of Longitude, to the Tangent of the Courſe: but more briefly thus:

Merid. Diff. Lat. .. Diff. Long. : : Radius .. T. of the Courſe.
2685 Minutes .. 3216 Min. : : T.45d. .. T. 50d. 09m.

Which being turned into Points of the Compaſs, makes the Courſe to be SW. half W. nearly.

2. To find the Diſtance, the Proportion by *Axiom* 1. *Note* 1. is this;

Making the Hypotenuſe AE Radius, the Leg AD is the Sine of the Angle AED, or the Sine Complement of the Courſe, and therefore it is,

As the Sine Complement of the Courſe, is to the proper Difference of Latitude; ſo is the Radius to the Diſtance in the Rhumb, Or more briefly thus;

S. c. Courſe .. Diff. Lat. : : Radius .. Diſtance required.
S. 39d. 51m. .. 2219Min. : : S. 90d. .. 3463 Minutes.

Note, The Meridional Difference of Latitude may be found by the *Gunter's-Scale*, thus;

Extend the Compaſſes from the Latitude of 49d. 57m. (on the Meridional-line) to the Latitude 12d. 58m. on the ſame Line;

ine ; that Extent meaſured on the Line of equal Parts will be 4$\frac{75}{100}$d. or 2685 Minutes, the Meridional Difference of Latitude, hich is the ſame as by the Table.

roblem III. *Both Latitudes and Courſe given; to find the Diſtance, and Difference of Longitude.*

Examp. A Ship ſails from the *Lizard*, and makes her Courſe when Variation, Lee-way, *&c.* are allowed for) to be S. 39d. W. or SW. by S. ½ W. and then by Obſervation, is in Latitude 5d. 31m. N. I demand the Diſtance run, and the Longitude he is in?

		d. m.		Minutes
Lizard	Latitude	49 57 N.	Meridional Parts	3470
Obſerved		45 31 N.		3074
Difference of Lat.		4 26	Mer. Diff. Lat.	— 396
		60		
Or ————		266 Minutes.		

To delineate this, or any of the ſeven next Problems, by the Plane Scale, as alſo their Reſolutions by Plane Trigonometry, the Directions and Notes in the foregoing Problem may be ſufficient Inſtructions, and therefore they are omitted 'till I come to Problem 10.

1. To find the Diſtance, the Proportion (as in Plane Sailing) is this:

S. c. Courſe ·· Diff. Lat. : : Radius ·· Diſtance.

S. 51d. 00m. ·· 266 Min. : : S. 90d. ·· 342$\frac{3}{10}$ Minutes.

2. To find the *Difference of Longitude*, the Proportion is this,

Radius ·· T. Courſe : : Merid. Diff. Lat. ·· Diff. of Long.

T. 45d. ·· T. 39d. : : 396 Minutes ·· 320$\frac{7}{10}$ Min. or 5d. 21m.

Or thus; the Extent on the Meridional Line (on the *Gunter*) from Latitude 49d. 57m. to Latitude 45d. 31m. meaſured on the Line of equal Parts, is 6d.$\frac{6}{10}$ the Meridional Difference of Latitude; and then you may ſay,

T. 45d. ·· T. 39d. : : 6d.$\frac{6}{10}$. ·· 5d.$\frac{35}{100}$. or 5d. 21m. the Difference of Longitude, as is found above.

3. Then to find the Longitude the Ship is in, 'tis thus,

Longitude ſailed from ————	5d. 14m. Weſt.
Difference of Longitude 321 Minutes, or	5d. 21m. Weſt.
Longitude the Ship is in ————	10d. 35m. Weſt.

Prob.

Problem IV. *Both Latitudes and Diſtance given; to find the Courſe, and Difference of Longitude.*

Example. If a Ship runneth 300 Minutes North Weſtward, from a Port in Lat. 37d. N. and Longitude 10d. 25m. W. until ſhe be in Latitude 41 Degrees North: I demand the Courſe ſteered, and what Longitude ſhe is in?

Sailed from } Latitude { 37d. North } Merid. Parts { 2393
Ship is in } Latitude { 41d. North } Merid. Parts { 2702
Difference of Latitude 4 North, Merid. Diff. Latit. 309
60
Or 240 Minutes.

1. To find the Courſe, the Proportion (as in Caſe the 4th of Plane Sailing) is thus;

Diſtance ·· Radius : : Diff. Lat. ·· S. c. Courſe.
300Min. ·· S. 90d. : : 240 Min. ·· S. 53d. 08m. Which
ſubtract from ——————— 90d. 00m.

Remainder is the Courſe ——— 36d. 52m. North Weſterly 3 ¼ Points of the Compaſs, which makes the Courſe to be NW. by N. ¼ W. neareſt.

2. To find the Diff. of Longitude, the Proportion is thus;
Radius ·· T. Courſe : : Merid. Diff. Lat. ·· Difference Long.
T.45d. ·· T.36d. 52m. : : 309 Minutes ·· 232 Min. or 3d. 52m.

Or thus, the Extent (on the *Meridional Line on the Gunter*) from Latitude 37d. to Latitude 41d. meaſured on *Equal Parts*, is 5d. 10m. Meridional Difference of Latitude. Then ſay, T. 45d. ·· T. 36d. 52m. : : 5d. $\frac{17}{100}$ ·· 3d. 88 Parts of 100, or 3d. 52m. the Difference of Longitude as before.

Longitude ſailed from ——————— 10d. 25m. Weſt
Difference of Longitude, is 232 Minutes or 3d. 52m. Weſt

Longitude the Ship is in ——————— 14d. 17m. Weſt

Problem V. *Both Latitudes and Departure from the Meridian given; to find the Courſe, Diſtance and Difference of Longitude.*

Example. A Ship in Latitude 49d. 57m. North, and Longitude 5d. 14m. Weſt, ſails South Weſtward, till her Departure is 789 Minutes, and by Obſervation is in Latitude 39d. 20m. North: I demand the Courſe ſteered, Diſtance ſailed by the Log, and what Longitude the Ship is in?

The

1. The Proportion for the Courſe and Diſtance, are the ſame
s in *Chapter* 3. *Section* 3. *Problem* 6. of *Plane-Sailing*, in *Page*
3. to which I refer you, and here omit them.

2. To find the Difference of Longitude, the Proportion is;

at. { Departed 49d. 57m. N. } Merid. Pts. { 3470 } Min.
at. { Ship is in. 39d. 20m. N. } Merid. Pts. { 2571 } Min.
iffer. of Latit. 10d. 37m. Mer. Diff. Lat. 899 Min.
60

Or, 637 Minutes. Then you may ſay,

s Diff. Lat. ·· Departure : : Merid. Diff. Lat. ·· Diff. Longit.
s 637 min. ·· 789 Min. : : 899 Min. ·· 1114m. or 18d. 34m.

Or thus; The Extent (on the Meridional Line on the *Gunter*) om Latitude 49d. 57m. to Latitude 39d. 20m. meaſured on e Line of equal Parts) is 15d. the Meridional Difference of Latude: And then ſay,

As 637 Minutes ·· 789 Min. : : 15d. ·· 18.55 hundredths or 18d. 33m. the Difference of Longitude, nearly as before.

3. Then, to find the Longitude the Ship is in, 'tis thus;

ongitude ſailed from ——————— 5d. 14m. Weſt.
ifference of Longitude 1114 Min. or ——— 18d. 34m. Weſt.

ongitude the Ship is in ——————— 23d. 48m. Weſt.

roblem VI. *One Latitude, Courſe, and Diſtance given; to find the Difference of Latitude, and Difference of Longitude.*

Example. A Ship in Latitude 42d. 30m. North, and Longide 18d. 31m. Weſt, ſails SE. by S. 591 Minutes, or 197 eagues: I demand the Latitude, and Longitude the Ship is in?

1. For the Difference of Latitude, the Proportion (by the *1ſt*
ſe of Plane Sailing, in *Page* 60) is thus:

s Radius ·· Diſtance : : S. c. Courſe ·· Difference of Latitude.
s S. 8 Points ·· 591 Min. : : S. 5 Pts. ·· 491.4 Min. or 8d. 11m.
atitude ſailed from —— 42d. 30m. N. Merid. Parts 2822m.
iff. Lat. 491 Min. or — 8d. 11m. S.

atitude the Ship is in — 34d. 19m N. Merid. Parts 2195m.

ubtract, giveth the Meridional Difference of Latitude 627m.

Or thus; The Extent (on the Meridional Line on the *Gun-*
r) from Latitude 42d. 30m. to Latitude 34d. 19m. meaſured

on the Line of equal Parts is 10d. $\frac{5}{10}$ or 10d. 30m. the Meridional Difference of Latitude.

2. To find the Difference of Longitude, the Proportion is,
As Radius ·· T. Courſe : : Merid. Diff. Lat ·· Differ Longitude.
As T.4Pts. ·· T.3Points : : 627 Minutes ·· 419m. or 6d. 59m.
Or thus ;
As T.4Pt ·· T.3Pts. : : 10d. $\frac{5}{10}$ ·· 6d. 59m. Diff. Long. as before.

Longitude ſailed from ———————— 18d. 31m. Weſt.
Diff. Long. 419 Minutes, or ———— 06d. 59m. Eaſt.

Longitude the Ship is in ———————. 11d. 32m. Weſt.

Problem VII. *One Latitude, Courſe, and Departure given, to find the Diſtance, Difference of Latitude, and Difference of Longitude.*

Example. A Ship ſails E.S.E. from a certain Port in Latitude 50d. 10m. South, and Longitude 10d. 16m. Eaſt, until the Departure from the Meridian be 957 Minutes : I demand her Diſtance ſailed, the Latitude and Longitude ſhe is in ?

1. The Diſtance is 1035 } Min. by Chapter 2. Section 3.
2. The Diff. of Lat. 396.4 }
Problem 3. of *Plane-Sailing*, in Page 61. Then the Latitude the Ship is in, and the Meridional Difference of Latitude, is found thus : Min.
Latitude ſailed from 50d. 10m. South, Merid. Parts — 3490
Diff. Latitude 396m. or 6d. 36m. S.

Latitude Ship is in —— 56d. 46m. S. Meridional Parts — 4157

Subtract, giveth the Meridional Difference of Latitude — 667

3. *To find the Difference of Longitude, the Proportion is,*
As Diff. Lat. ·· Departure : : Merid. Diff. Lat. ·· Diff. of Long.
As 396.4 Min. ·· 957 Min. : : 667 Min. ·· 1610m. or 26d. 50m.
Or thus; the Extent (on the Meridional Line on the *Gunter*) from Latitude 50d. 10m. to Latitude 56d. 46m. meaſured on the Line of Equal Parts ; is 11d. $\frac{1}{10}$ the Merid. Diff. of Lat.
Then ſay,
As 396.4 Min. ·· 957 Min. : : 11 $\frac{1}{10}$ ·· 26d. 50m. the Diff. Lon.
Then to find the Longitude the Ship is in, it's thus :

Longitude ſailed from ———————. 10d. 16m. Eaſt.
Difference of Longitude 1610 Min. or —— 26d. 50m. Eaſt.

Longitude the Ship is in ———————— 37d. 06m. Eaſt.

Prob.

ob. VIII. *One Latitude, Diſtance ſail'd, and Departure from the Meridian given, to find the Courſe, Difference of Latitude, and Difference of Longitude.*

Example. A Ship in Latitude 49d. 30m. North, and Lontude 14d. 40m. Weſt, ſails South Eaſtward 645 Minutes, itil the Departure from the Meridian be 500 Minutes: I deand the Courſe ſteered, the Latitude, and Longitude the Ship in?

1. The Courſe is S. 50d. 50m. E. or SE. ½ E.
2. The Diff. of Lat. 407 min. or 6d. 47 min. } by *Chap.* 3.
ction 3. *Problem* 5. *of* Plane-Sailing, *in Page* 62 *and* 63. hen the Latitude the Ship is in, and the Meridional Difference Latitude, is found thus; Min.

Latitude ſailed from —— 49d. 30m. N. Merid. Parts 3428
Diff. Lat. 407 min. or — 6d. 47m. S.
titude the Ship is in —— 42d. 43m. N. Merid. Parts 2840
Meridional Difference of Latitude 588

3. To find the Difference of Longitude, the Proportion is;
Diff. Lat. ·· Depart. : : Merid. Diff. Lat. ·· Diff. of Long.
407 min. ·· 500 m. : : 588 min ·· 722.4 min. or 12d. 02m.

Or thus; The Extent (on the Meridional-line on the Gunter) m Latitude 49d. 30m. to Latitude 42d. 43m. (meaſured on ual Parts) is 9d. $\frac{8}{10}$, the Meridional Difference of Latitude: hen ſay,

As 407 min. .. 500 min. : : 9d. $\frac{8}{10}$ ·· 12d. 2m. the Diff. Long.

Then, to find the Longitude the Ship is in, 'tis thus;

Longitude ſailed from ———————— 14d. 40m. Weſt.
Diff. Longit. 722.4 Minutes, or ——— 12d. 02m. Eaſt.
Longitude the Ship is in ———————— 2d. 38m. Weſt.

oblem IX. *One Latitude, Courſe, and Difference of Longitude given, to find the Diſtance, and Difference of Latitude.*

Example. A Ship ſails SW. by W. from the *Lizard*, until ſhe in Longitude 57d. 26m. Weſt. I demand the Latitude the ip is in, and her Diſtance ſail'd?

Longitude ſailed from ———————— 5d. 14m. Weſt.
Longitude the Ship is in ———————— 57d. 26m. Weſt.
btract, and Remainder is the Diff. Long. 52d. 12m. Weſt.
60
Or 3132 Minutes.

1. For the Mer. Difference of Latitude, the Proportion ma be thus;

As T. Courſe .. Radius : : Differ. Long. .. Mer. Diff. of Lat

As T. 5 Pts. .. T. 4Pts. : : 3132 Minutes .. 2093 Minutes.

Lat. ſailed from 49^{d}. 57^{m}. its Merid. Parts — $\underline{3470}$ ſubtract

giveth the Mer. Pts. for the Lat. the Ship is in 1377 which ſeek i the Table of Meridional Parts; and againſt it you will find 22 22m. the Latitude the Ship is in North.

Or thus, on the *Gunter*; take the Meridional Difference c Latitude, being 2093 Minutes, or 34^{d}. 53^{m}. from the Line c equal Parts, and ſet it from the Latitude departed from, *viz.* 49 57^{m}. on the Meridional Line decreaſing (becauſe 'tis North La titude, and ſailing Southerly) and it reacheth (in the ſame Line to 22d. 20m. the Latitude the Ship is in, very near to the Lati tude found above by the Table of Meridional Parts, differing fron it but 2 Minutes.

Then having both Latitudes known, the Difference of Lati tude is found (by ſubtracting the leſs from the greater) to be 27 35m. or 1655 Minutes, or 551 ⅔ Leagues.

2. Find the Diſtance ſailed by Chapter 3. Section 3. Probler or Caſe 2. of *Plane-Sailing*, in page 61.

Problem X. *Two Places in one Parallel, or Latitude, their Diff rence of Longitude given; to find their Diſtance.*

Example. I demand the Diſtance between the *Lizard* a *Pengwin Iſland* on *Newfoundland*?

Pengwin Iſland	Longit. is	52^{d}. 50m. Weſt
Lizard		5d. 14m. Weſt
Subtract, and Remainder is Diff. Long.	——	47^{d}. 36m. Weſt
	Or,	60
Difference of Long.		2856 Minutes.

Theſe Places are both (ſuppoſed to lie) in Latitude 50d. co North, whoſe Complement is 40d. 00m.

To delineate this Problem by the Plane Scale.

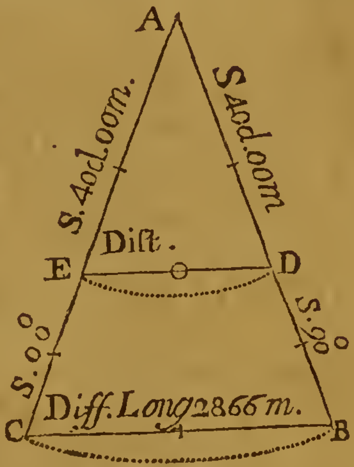
1. Draw the prick'd Arc BC, with the Sine of 90 Degre one Foot being on the Center A.

2. Lay the Difference of Longitude on that Arc, from B to and draw the Lines AB, AC, and BC.

3. W

3. With the Sine Com-lement of the Latitude and ne Foot in A, draw the rc DE; that is, take the omplement of the Latitude from the Line of Sines, nd with one Foot on A, raw the prick'd Arc DE, o cut AB in D, and AC in E.

4. Draw a Line from D o E. and 'tis done; for D E being meaſured on the ame Scale BC was taken rom, will ſhew the Diſtance equired.



The Explanation of the Scheme.

1.	The Punct	A	represents the	North Pole of the Earth.
2.		D		*Lizard.* } in the Latitude of 50d. 00m.
3.		E		*Pengwin Iſle.* } in the Latitude of 50d. 00m.
4.	The Arc	BC		Equator.
5.		DE		Parallel of 50d. N. Latitude.
6.	The Line	ADB		Meridian of The *Lizard.*
7.		AEC		Meridian of *Pengwin Iſland.*
8.		BC		Diff. Long. between the 2 Places.
9.		DE		Diſt. between them in that Parallel.

Then to find their Diſtance; the Proportion, by the 4th Propoſition of the ſixth Book of *Euclid*, is,

As AB, is to BC; ſo is AD, to DE. And alternately,

As AB, is to AD; ſo is BC, to DE. That is,

As Radius, is to the Sine Complement of the Latitude; ſo is the Difference of Longitude, to their Diſtance in that Parallel of Latitude. In ſhort thus;

As Radius .. S. c. Latitude : : Diff. Long. .. Diſtance.

As S. 90d. .. S. 40d. com. : : 2856 Min. .. 1836 Min.

Or thus; By the *Plane Scale*.

Take the Latitude of 50d. 00m. from the Scale of Chords, and meaſure it from 60 on the Scale of Miles of Longitude, marked (ML) and it ſheweth Minutes 38.6 Tenths makes a Degree of Longitude in that Latitude. Then ſay,

As 1 Deg. .. Min. 38.6 : : Diff. Long. 47d. $\frac{6}{10}$ .. 1836 Minutes, the Diſtance as before.

Problem XI. *Two Places in one Latitude, their Diſtance given; to find their Difference of Longitude.*

Example. If a Ship ſails Weſt 390 Minutes from the *Lizard*; What Longitude is ſhe in?

To delineate this *Problem* by the *Plane Scale*.

1. Take 90 Degrees from the Line of Sines, and with one Foot on A, draw the prick'd Arc BC.
2. From the Line of Sines, take the Complement of the given Latitude, and ſetting one Foot on A, draw the prick'd Arc DE.
3. Then from any Scale of equal Parts, take the Diſtance (*ſail'd)* and lay it on the laſt Arc, from D to E.
4. From A draw Lines through D and E, to cut the Arc BC, in B, and in C.
5. Then draw a Line from B to C, and 'tis done; for BC being meaſured on the ſame Scale DE was taken from, will ſhew the Difference of Longitude required.

The Proportion (by the 4th Propoſition of the 6th Book of *Euclid)* for the Difference of Longitude, is,

As S. c. Latitude .. Radius : : Diſtance .. Difference of Long.

As S. 40d. 03m. .. S. 90d. : : 390min. .. 606.1m. or 10d. 06m.

Or thus; By the *Plane Scale*.

The Latitude 49d. 57m. taken (from the Chords) and meaſured on the Scale of Miles of Longitude, ſheweth the Minutes 38.6 Tenths makes a Degree of Longitude in that Latitude; Then ſay,

As Min. 38.6 Tenths .. 1d. : : 390 min. .. 10d. $\frac{1}{10}$ or 10d. 06m. Diff. Long. the ſame as before.

Longitude of the *Lizard* ———— ———— — 05d. 14m. Weſt.
Difference of Longitude 606 $\frac{1}{10}$ min. or — 10d. 06m. Weſt.

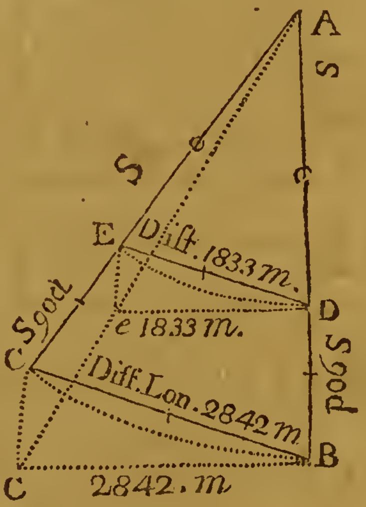
Add, gives the Longitude the Ship is in —— 15d. 20m. Weſt.

Prob.

Problemn XII. *Two Places in one Parallel of Latitude, their Diſtance, and Difference of Longitude given, to find the Parallel of Latitude.*

Example. *Suppoſe two Ships in the Equator* 2842 *Minutes aſunder, and they both ſail North like Diſtance, till there are but* 1833 *Minutes aſunder: I demand what Latitude they are now in?*

To delineate this Problem *by the* Plane-Scale.



1. Draw the prick'd Arc BC, (with the Sine of 90 Degrees, one Foot being on the Center A) to cut the Lines AB in B.

2. On B erect the prick'd Perpendicular B c, and thereon lay the Difference of Longitude from B to c.

3. Draw the prick'd Line AC.

4. Then with the Diſtance in the Parallel, and one Foot in the prick'd Line A c, moved upon that Line, 'till the other Foot turned about, will but juſt touch the Line AB, and where the former Foot reſteth, which is at e, there ſtay it.

5. Take the neareſt Diſtance from e, to the prick'd Line B c, and lay that Diſtance on the Line AB, from B to D, and draw the prick'd Line D e.

6. Lay the Difference of Longitude on the prick'd Arc, made with the Sine of 90 Degrees, from B to C, and draw the Line A C; alſo with the Diſtance A D, and one Foot on A, draw the prick'd Arc DE, to cut AC in E; likewiſe draw Lines from B to C, and from D to E, and 'tis done: for AD, or AE meaſured on the Scale of Sines, will ſhew the Complement of the Latitude required.

Note; If B c be equal to BC and D e equal to DE, 'tis done true, otherwiſe not; as the prick'd Arcs c C, and e E manifeſt.

To find the Latitude (by the aforeſaid Propoſition of *Euclid*) the Proportion is thus;

As Diff. Long. .. Diſtance : : Radius .. S. c. Latit. required
As 2842 Min. .. 1833 min.: : S. 90d. .. S. 40d. 10m.
Which ſubtracted from ——————— 90d. 00m.
The Remainder is the Parallel of Latitude — 49d. 50m. North.

Or thus; By the *Plane Scale.*

As 2842 min. .. 1833 min. : : 60 min. .. min. 38.7 Tenths, making one Degree of Longitude, in the Latitude required.

Then from the Scale of Miles of Longitude (marked ML) take Min. 38.7 Tenths, meaſure it on the Scale of Chords, and it ſheweth the Latitude to be 49d. 50m. as before.

Section IV. *Problems of Sailing by the Middle Latitude; or a Proportion drawn from the Middle Latitude, nearly agreeing with* Mercator's-Sailing.

IN theſe Problems, there is no Uſe made of the Table of Meridional Parts, and all its Proportions may be wrought both by the Logarithms, and *Gunter's-Scale*.

Problem I. *The Latitude and Longitude of two Places given; to find their Courſe and Diſtance.*

Example. What is the Courſe and Diſtance from the *Lizard* to the Iſland *Barbadoes*;

		d. m.		d. m.		d. m.
Lizard	Lat.	49 57 N.	—	49 57	Long.	5 14 W.
Barbadoes		12 58 N.	—	12 58		58 50 W.

Difference Latitude 36 59 S. Sum is 62 55 Diff. Long. 53 36 W.
60 Mid. Lat. 31 27 60
Minutes 2219 ſubt. it from 90 00 or 3216 min.
Comp. Mid. Lat. 58 33

To delineate this Problem by the Plane-Scale. *Plate* 3. *Fig* 6.

1. Make AD upon the Meridian equal to the Difference of Latitude.
2. Draw the prick'd Arc IK, with the Sine of 90 Degrees (one Foot being on A) to cut the Meridian AD in I.
3. With the Sine Complement of the Middle Latitude, and one Foot on A, draw the prick'd Arc GH, to cut the Meridian in G.

4. On the laſt Arc, lay half the Difference of Latitude, om G to H.

5. By A and H, draw a Line, to cut the firſt Arc (made ith the Sine of 90 Degrees) in K.

6. Lay IK twice on the Meridian, from A to B.

7. On B erect a Perpendicular, and thereon lay the Difference f Longitude, from B to C.

8. Draw a Line from A to C; and from D, draw D E pa-allel to BC, and cut AC in E, and it's done. *Plate* 3. *Fig.* 6.

Then is the Leg AD, the Difference of Latitude.
The Leg BC, the Difference of Longitude.
The Hypotenuſe AE, the Diſtance of the two Places.
The Leg DE, the Departure, according to the *Plane-Chart.*
The Angle D A E, or B A C, the Angle of the Courſe or Bearing.
The Angle AED, the Complement of the Courſe.

1. *To find the Courſe, or Bearing,* the Proportion is;

As the Difference of Latitude, is to the Difference of Longitude; ſo is the Sine Complement of the middle Latitude, to the Tangent of the Courſe, or more briefly thus:

As Diff. Lat. .. Diff. Long. : : S. c. Mid. Lat. .. T. Courſe.
As 2219 min. .. 3216 min. : : S. 58d. 33m. .. T. 51d. 02m.

By *Gunter.* The Extent from 2219 Minutes to 3216 Minutes on the *Line of Numbers*, being laid (increaſing) from Sine 58d 33m. reacheth beyond the Sine of 90d. wherefore lay that Extent from the Sine of 90 Degrees towards the *Left-hand*, and ſtay one Foot there, then bring in the other Foot to the Sine Complement of the Middle Latitude 58d. 33m. this laſt Extent of the Compaſſes, lay from Tangent 45 Degrees, and it ſheweth on Tangents 51d. 02m. the Courſe South Weſterly, or SW. half W. which is the Courſe from the *Lizard* to the Iſland *Barbadoes.*

Or thus; by two Proportions to find the Courſe.

Firſt, As the Radius, is to the Sine Complement of the Middle Latitude; ſo is the Difference of Longitude, to the Departure from the Meridian, or Meridional Diſtance.

More briefly thus;

As Radius .. S. c. Middle Lat. : : Diff. Long. .. Departure.
As S. 90d. .. S. 58d 33min. : : 3216 Min. .. 2744 min.

Secondly, As the Difference of Latitude, is to the Departure from the Meridian; ſo is the Radius, to the Tangent of the Courſe.

Or more briefly thus;
As Diff. Lat. .. Departure : : Radius .. T. Courſe.
As 2219 min. .. 2744 min. : : T. 45d. .. T. 51d. 02m. as before.
2. To find the Diſtance, the Proportion is,
As S. c. Courſe .. Diff. Lat. : : Radius .. Diſtance required.
As S. 38d. 58m. .. 2219 min.: : S. 90d. .. 3528 Minutes.

Problem II. *Both Latitudes and Courſe given; to find the Diſtance, and Difference of Longitude.*

Example. Suppoſe a Ship ſails from the *Lizard*, and makes (when Variation, Lee-way, *&c.* allowed for) her Courſe South 39d. Weſt, or SW by S ½ W. and then by Obſervation, is in Latitude 45d. 31m. North; what's her Diſtance run, and Longitude ſhe is in?

Lizard } Latitude { 49d. 57m. North —————— 49 57
Obſerved } Latitude { 45d. 31m. North —————— 45 31
Difference of Latitude 4d. 26m. Sum both Latitude 95 88
60 The half is Mid. Lat. 47 44
Or, Minutes 266 which ſubtract from 90.00
The Remainder is Compl. of the Middle Latitude —— 42 16

To delineate this, or any of the following *Problems*, by the *Plane Scale*, the Inſtructions in the foregoing are ſufficient to inform the diligent Learner.

1. The Diſtance is 342.3 Minutes by *Chapter* 6. *Section* 3. *Problem* 3d. of *Mercator's-Sailing*, in Page 95.

2. To find the Difference of Longitude; the Proportion is,

As the Sine Complement of the Middle Latitude, is to the Tangent of the Courſe, ſo is the Difference of Latitude, to the Difference of Longitude, Or thus:
As S. c. Mid. Lat. .. T. Courſe :: Diff. Lat. ·· Diff. of Long.
As S. 42d. 16m. .. T. 39d. : : 266 min. .. 320.3 min.

To work this, or any ſuch like Proportion, by *Gunter's Scale*, the General Rule of extending from the Firſt Term to the Second, *&c.* will not ſerve, till the Firſt and Second Terms are reduced to one Line, or Scale, and that by this Rule following.

A General Rule to reduce the Second Term Tangent, *to the Firſt* Term Sine.

Extend the Compaſſes from Tangent 45d. to the Tangent of the Second Term; lay that Extent on the Line of Sines, from 90d. (if the Second Term be leſs than 45d. but if more, from the irſt Term) towards the Left-hand; and where the Foot reſteth, call the Second Term reduced to the Firſt, and is to be counted nſtead of the Second Term; as for *Example.*

To work the aforeſaid Proportion, to find the Difference of ongitude.

1. The Extent from Tangent 45d. to Tangent 39d. laid from ine 90d. reacheth to 54d 05m. the Second Term reduced to he Firſt Term.

2. The Extent from 54d. 05m. (the Second Term reduced) o Sine 42d. 16m. the Firſt Term in the Proportion; laid on the ine of Numbers from 266 Minutes, the Third Term, will reach o 320.3 Minutes, the Fourth Term, the Difference of Longi- ude required.

Or thus; By two Operations to find the Difference of Longitude.

Firſt; As the Sine Complement of the Courſe, is to the Dif- erence of Latitude: So is the Sine of the Courſe, to the Depar- ure from the Meridian, or Meridian Diſtance. *Or thus*;

As S. c. Courſe .. Diff. Lat. : : S. Courſe .. Departure.
As S. 51 deg. .. 266 min. : : S. 39 deg. .. 215.4 min.

Secondly; As the Sine Complement of the middle Latitude, s to Radius: ſo is the Departure from the Meridian, to the Dif- erence of Longitude. Briefly thus;

As S. c. Middle Lat .. Radius : : Departure .. Diff. Long.
As S. 42d. 16m. .. S. 90d. : : 215.4 min. .. 320.3 as before.

Then to find the Longitude the Ship is in, 'tis thus.

Lizard Longitude is ———————— 05d. 14m. Weſt.
Diff. Longitude 320.3 Minutes, or —— 05d. 20m. Weſt.
Longitude the Ship is in ———————— 10d. 34m. Weſt.

roblem III. *Both Latitudes, and Diſtance given; to find the Courſe and Difference of Longitude.*

Example. If a Ship runneth 300 Minutes North Weſterly, rom a Port in 37 deg. North Latitude, and Longitude 10d. 5m. W. until ſhe be in Lat. 41d deg. North: What is her ourſe and Longitude ſhe is in?

Sailed from } Latitude { 37d. North ———————— 37d.
Ship is in--- } Latitude { 41d. North ———————— 41d.
ifference of Latitude —— 4d. N. Sum of both Latit. 78d.
60 Middle Latit. 39d.
Or, Minutes 240 Subtract from 90d.
Complement of the Middle Latitude 51d.

1. The Courſe is North 36 deg. 52 min. Weſt, or NW. by N. ¼ Weſt neareſt; found by Chapter 4. Section 3. Problemn 4. of *Mercator's Sailing*, in Page 96.

2. To find the Differ. of Longit. the Proportion is thus;

As S. c. Mid. Lat. .. T. Courſe : : Differ. Lat. .. Diff. Long.
As S. 51d. 30m. .. T. 36d 52m. : : 240 min. .. 231.6min.

By *Gunter's Scale*. The Extent from Tangent 45d. to Tangent 36d. 52m. will reach from Sine 90d. to Sine 48d. 30m. the Second Term reduced to the Firſt: Then the Extent from this laſt (Sine 48d. 30m.) to Sine 51d. (the Firſt Term in the aboveſaid Proportion) will reach on the Line of Numbers from the Difference of Latitude 240 Minutes, to 231.6 Minutes, or 3d. 52m. the Difference of Longitude.

Or thus; By two Proportions (after the Courſe is found, as before) to find the Difference of Longitude, ſay,

1. As the Radins, is to the Diſtance ſailed; ſo is the Sine of the Courſe to the Departure from the Meridian:

Which briefly is thus;

As Radius .. Diſtance : : S. Courſe .. Departure.
As S. 90d... 300 min. : : S. 36d. 52m. .. 180 Minutes.

2. As the Sine Complement of Middle Latitude, is to Radius; ſo is the Departure from the Meridian, to the Difference of Longitude. Briefly is thus;

As S. c. Mid. Lat. .. Radius : : Departure .. Diff. Long.
As S. 51 Degrees. .. S. 90d. : : 180 Min. .. 231.6 Min.

Or it may be found by this Proportion, when the Diſtance is given.

S.c. Mid. Lat... Diſtance : : S. Courſe .. Diff. Longit.
S. 51 Degrees .. 300Min. : : S. 36d. 52m. .. 231.6m. as above.

Then to find the Longitude the Ship is in, 'tis thus;

Longitude the Ship ſailed from ———— 10d. 25m. Weſt.
Diff. Longitude 231.6 Minutes, or —— 3d. 52m. Weſt.

Longitude the Ship is in ———————— 14d. 17m. Weſt.

Problem IV. *Both Latitudes, and Departure from the Meridian given; to find the Courſe, Diſtance, and Difference of Longitude.*

Example. A Ship in Latitude 49d. 57m. North, and Longitude 5d. 24m. Weſt; ſails South Weſterly, 'till the Departure be 789 Minutes, and ſhe be in Lat. 39d. 20m. North; I demand the Courſe, Diſtance, and Longitude the Ship is in?

Lat.

Latitude { Sail'd from 49d. 57m. North ——— 49d. 57m.
Ship is in 39d. 20m. North ——— 39d. 20m.

Difference of Latitude 10d. 37m. Sum of both Lat. 89d. 17m.
60
Or Minutes —— 637 The ½ is Mid. Lat. 44d. 38m.
Which ſubtract from--- 90d. 00m.

The Remainder is Comp. of the Middle Latitude--- 45d. 22m.
1. The Courſe is S. 51d. 05m. W. } by *Chapter* 4 *Section*
2. Diſtance 1014 Minutes. } 3. *Problem* 5. of *Mercator's Sailing, in Page* 97.

3. To find the Difference of Longitude, the Proportion is;
As S. c. Mid. Lat. .. T. Courſe : : Diff. Lat. .. Diff. Long.
As S. 45d. 22m. .. T. 51d. 05m. : : 637 min. .. 1109 Min.

For the Extent from Tangent 45d. to the Tangent 51d. 05m. laid (on the Line of Sines) from 45d. 22m. reacheth to Sine 35d. 10m. the Second Term reduced to the Firſt: Then the Extent from this laſt (Sine 35d. 10m.) to S. 90d. (inſtead of Sine 45d. 22m. the Firſt Term in the above Proportion, always when the Courſe is more then 45d. and that) laid on the Line of Numbers, from Diff. Lat. 637 Minutes will reach to 1109 Minutes, the Difference of Longitude required.

Or thus; the Difference of Longitude may be found without finding the Courſe, ſaying:
As the Sine Complement of the Middle Latitude, is to the Radius: ſo is the Departure from the Meridian, to the Difference of Longitude. That is,
As S. c. Mid. Lat. .. Radius : : Departure .. Differ. Longit.
As S. 45d. 22m. .. S. 90d. : : 789m. Min. .. 1109m. as before.
Then the Longitude the Ship is in, may be found, as in *Problem* 5. of *Mercator's Sailing*, in *Page* 97, that being the ſame Queſtion with this.

And in like manner all the remaining Queſtions in *Mercator*, may be wroght by the Sine Complement of the middle Latitude, which I leave to the Learner's Practice: And thus much may ſuffice for the Second Kind of Sailng, or ſecond Part of Navigation, and the Application of Plane Trigonometry; Spheric Trigonometry, is next.

Chapter V. *Containing the Doctrine of Spheric Triangles, Rectangular and Oblique, both Geometric, Logarithmic, and Inſtrumental.*

BEFORE I enter on Speric Trigonometry, as to the framing and working of Proportions therein, it will be neceſſary you ſhould underſtand how to make a Speric Triangle, and to meaſure any of its Parts: In Order thereunto I have contrived the following Problems, which I call Spheric Geometry.

Section I. Spheric Geometry *explained by Difinitions and Problems.*

Definition 1. S*Pheric Geometry*, is that by which the Circles of the Sphere are deſcribed, drawn, or projected on a Plane, or flat Superficies,

2. A *Sphere* or *Globe*, is a round Body, made by the moving of a Semi-circle about its own Diameter, till the Motion end where it began.

3. The *Projection of the Sphere*, is either Orthographic, Stereographic, or Gnomonic.

4. *Orthographic* is the drawing the Superficies of the Sphere on a Plane, which cutteth the Sphere in the middle, with reſpect to the Eye being placed perpendicular to it, and at an infinite Diſtance therefrom: This Projection maketh Uſe only of the Lines of Chords, and Sines.

5. *Stereographic*, ſheweth how to deſcribe the Sphere's Superficies on a Plane, which cutteth it in the middle, with reſpect to the Eye being placed in the Sphere's Superficies, perpendicular to the Center of the ſaid Plane.

6. *Gnomonic Projection of the Sphere*, is drawing the Superficies on a Plane touching it, with reſpect to the Eye being placed in the Sphere's Center.

Theſe two laſt make uſe of the Lines of Chords, Tangents, and Secants.

7. All Circles of the Sphere, are either Great Circles, which cut it into two equal Parts; or leſſer Circles, which cut it into two unequal Parts.

8. The Place on which the Sphere is projected, is that Circle hich bounds, or limits the Projection, and is repreſented by the ircle ABCDEBA. *Plate* 3. *Fig* 7.

9. A *Great Circle*, is either the Primitive Circle, a Right ircle, or an Oblique Circle.

Theſe Circles conſidered ſeverally, or jointly, afford divers roblems, which are the ſubject Matter of *Spheric Geometry*, ıd are ſuch as follow.

Problem. I. *To find the Pole of any Great Circle.*

Definition 1. A *Great Circle*, is either the Primitive Circle, as CDEB; or a Right Circle, as the Diameter BAD; or an)blique Circle, as the Arc BFD. *Plate* 3. *Fig.* 7.

2. *The Pole of a Great Circle*, is a Punct every Way 90 Derees diſtant from it: And

Note 1. The Pole of a Great Circle is either upon the Primive Circle, or within it.

2. When the Pole is within, 'tis either at the Primitive Circle's enter, or not.

In this Problem are three Caſes.

roblem I. Caſe 1. *The Pole of the Primitive Circle is required.*

Example. BCDE the Primitive Circle given; to find the 'ole thereof is required. *Plate* 3. *Fig.* 7.

The Rule. Find A, the Center of the Primitive Circle CDE, which Center A, is the Pole required.

Problem I. Caſe 2. *The Pole of a Right Circle is required.*

Definition. A *Right Circle* paſſeth thro' the Center of the 'rimitive Circle, and in the Projection is a Diameter; as BAD.

Note, A Right Circle hath its Pole on the Primitive Circle.

Example. The Pole of the Right Circle BAD is required. *'late* 3. *Fig.* 7.

The Rule. From the Chords, lay 90 Degrees on the Primiive Circle from B or D, both ways to C and E; I ſay, C and E, re the Poles of the Right Circle BAD.

Problem I. Caſe 3. *The Pole of the Oblique Circle is required.*

Definition. An *Oblique Circle* paſſeth not through the Center of the Primitive Circle, and in the Projection is repreſented by an Arc; as BFD. *Plate* 3. *Fig* 7.

Note 1. The Poles of an Oblique Circle, are in a Diameter which paſſeth through its Center.

2. One of the Poles of an Oblique Circle, lieth between the Centers of the Primitive, and Oblique Circle.

3. Every Great Circle, whether Right, or Oblique, cutteth the Primitive diametrically oppoſite.

Example.

$\left.\begin{array}{l}\text{BCDE the Primitive}\\ \text{BFD the Oblique}\end{array}\right\}$ Circle and $\left\{\begin{array}{c}\text{A}\\ \text{y}\end{array}\right\}$ its Center given.

The Pole of the Oblique Circle BFD *is required. Plate* 3. *Fig.* 7.

The Rule. 1. Through A and y, draw a Diameter to cut the Primitive Circle in C and E, and the Oblique Circle in F.

2. Lay a Scale on B and F, to cut the Primitive Circle in g; which is called Reducing F, to the Primitive Circle.

3. Take 90 Degrees (from the Scale of Chords) and lay it on the Primitive Circle, from g both Ways to h.

4. Reduce h to the Diameter CAE, by laying a Scale on B and h, to cut the Diameter C A E, both within the Primitive Circle, and without, either of which Points, I, is the Pole of the Oblique Circle BFD.

Problem II. *To deſcribe a Spheric Angle.*

Definition. A *Spheric Angle*, is made by the Interſection of two Great Circles; the Interſection being the Angular Punct.

Note, In this Problem are two Caſes.

Problem II. Caſe 1. *To make an Angle, that the Angular Punct may be at the Center of the Primitive Circle.*

The Rule. Such an Angle is made (in all Reſpects) like a Plane Angle.

Example. An Angle B A C equal 40d. 30m. (whoſe Angular Punct A may be the Center of the Primitive Circle) is required to be made. *Plate* 3. *Fig.* 8.

1. With a Chord of 60 Degrees (on the Center A) deſcribe the Primitive Circle, BCDE.

2. On the Primitive Circle, and from the ſame Chords, make BC equal to 40d. 30m.

3. From B and C, draw two Right Circles, or Diameters, thro' A, which will include the Angle BAC required to be made.

Problem. II. Caſe 2. *To make an Angle, that the Angular Punct may be at the Primitive Circle.*

The Rule. Such an Angle is made by drawing an Oblique Circle, with the Secant of the given Angle.

Example. *An Angle* EBF *equal to* 34d. 30m. *(whoſe Angular unct* B *may be at the Primitive Circle) is required to be made?* ate 3. Fig. 7.

1. Deſcribe the Primitive Circle BCDE, as before directed.

2. Lay a Scale on A (the Primitive Circle's Center) and cut e Primitive Circle in B and D.

3. With the Secant of the given Angle 34d. 30m. and one ot in B, deſcribe an Arc y.

4. With the ſame, and one Foot on D, croſs the former Arc y; the Center of the Oblique Circle BFD, which will inide the Angle EBF equal to EDF, required to be made.

Note; When the given Angle is Obtuſe, take its Supplement to o Degrees, and with the Remainder make the Angle as above ected and 'tis done.

ob. III. *To draw a Great Circle through any given Punct, ſo that it ſhall make at the Primitive Circle any given Angle.*

The Rule. 1. With the Tangent of the given Angle and one ot on the Center of the Primitive Circle, make an Arc.

2. With the Secant of the ſame, and one Foot in the given nct, cut the former Arc, which Point of Interſection, is the nter of the Circle required to be drawn.

Example. *Plate* 3. *Fig.* 7.

BCDE the Primitive Circle }
A the Center thereof —— } given;
F the Punct ——— ——— }

rough F, to draw an Oblique Circle, that it may make an gle at the Primitive Circle, equal to 34d. 30m. is required?

Vote; The given Point muſt be ſo far from the Center of the nitive Circle, that the Tangent from the Center, and the ant (of the ſame) from the given Punct, may interſect, or each other; otherwiſe 'tis impoſſible.

. With the Tangent of 34d. 30m. and one Foot in A, make Arc y.

. Then with the Secant of the ſame, and one Foot in F, the Arc y, in the Center of the Oblique Circle BFD, reed to be drawn; and if B, and D, are diametrically oppoſite done true, otherwiſe not.

blem IV. *To draw a Great Circle, through any two Puncts iven; either both within the Primitive Circle, or one within, nd the other without.*

he Rule. 1. Draw a Line from the Primitive Circle's Center, one (always the remoteſt) of the two Puncts, to cut the nitive Circle, and produce it at Pleaſure.

2. From the ſaid Punct, draw another Line to a Punct in th Primitive Circle, that is 90d. Diſtance from the firſt Line.

3. On the laſt Line, and at the Punct in the Primitive Circle erect a Perdendicular, to cut the firſt Line in the third Punct.

4. Through the two given Puncts, and this laſt third Poin draw (by *Chapter* 1. *Section* 2. *Problem* 7. of *Practical Geometr* in Page 15.) an Arc of a Circle, and 'tis done.

Example. *Plate* 3. *Fig.* 9.

BCDE the Primitive Circle
A the Center thereof —— } given;
F and G two Puncts ——

Through F and G 'tis required to draw a Great Circle?

1. Through A and F, draw the Right Circle BFAD, to cut th Primitive Circle in B and D, and continue it further at Pleaſure.

2. Lay the Chord of 90d. on the Primitive Circle from B, o from D, to C or E, and draw the Line FC or FE.

3. At C erect CH perpendicular to CF, or at E erect EH pe pendicular to EF, to cut the Diameter BFAD in H, the thi Punct.

4. Through F, G, and H, draw a Circle IFGKH, which wi cut the Primitive Circle in I and K, diametrically oppoſite, an 'tis done.

Problem V. *To draw a great Circle perpendicular to, or at Rig Angles with a given Great Circle.*

A General Rule. Draw a Great Circle through the Pole, Poles of the given Great Circle, and 'tis perpendicular to it, or makes a Right Angle with it.

Note, In this *Problem* are four Caſes.

Problem V. Caſe 1. *To draw a Great Circle perpendicular the Primitive Circle.*

The Rule. This is done by drawing a Diameter through t Center of the Primitive Circle; for the Center of the Primiti Circle being its Pole, all Right Lines drawn through the Cent are perpendicular Circles to the Primitive Circle.

Example. Plate 3. *Plate* 7.

BCDE the Primitive Circle, and A its Center given; to dr a Great Circle perpendicular to it, is required?

Through A draw the Right Circle BAD, and 'tis perpendic lar to the Primitive Circle BCDE, as was required.

Proble

roblem V. Caſe 2. *To draw a Right Circle perpendicular to a given Right Circle.*

The Rule. This is done by drawing a Diameter at Right ngles to the given Right Circle; or quartering the Primitive ircle (by *Chapter* 1. *Section* 2. *Problem* 8. of *Practical Geomery*, in *Page* 15.) with two Diameters.

Example. *Plate* 3. *Fig.* 7.

BCDE the Primitive ⎫ Circle, ⎧ and A its Center ⎫ given;
BAD is a Right—— ⎭ ⎩ ———————— ⎭

To draw a Right Circle perpendicular to the Right Circle AD, is required?

Draw the Diameter CAE perpendicular to BAD, or from the hords lay 90d. on the Primitive Circle from B, or from D, to and E, which are its two Poles, and through C, A, and E, raw a Diameter, and 'tis done.

roblem V. Caſe 3. *To draw an Oblique Circle perpendicular to a given Right Circle.*

The Rule. 1. Find the two Poles of the given Right Circle, y *Problem* 1. *Caſe* 2. of *Spheric Geometry*, in *Page* 111.

2. Draw an Oblique Circle through thoſe two Poles, and 'tis one.

Example. *Plate* 3. *Fig.* 7.

BCDE the primitive Circle ⎫
A the Center thereof —— ⎬ given;
BAD is a Right Circle — ⎭

To draw an Oblique Circle, perpendicular to the Right Circle AD, is required?

1. Take the Chord of 90d. and lay it from B, or D, both ays to C, and E, which are the two Poles of the Right Circle AD.

2. With any Diſtance, and one Foot on C, and E, draw rcs to cut each other in x, the Center of the Oblique Circle GE, required to be drawn.

Note, If AG be known, or limited to a certain Diſtance, en 'tis done by drawing a Circle through the three Puncts C, , and E.

Or, 2. If AG be any known Quantity of Degrees, then take e Secant of its Complement, and ſetting one Foot on C, or E, e other will croſs the given Right Circle, in the Center of the blique Circle required to be drawn.

Problem V. Caſe 4. *To draw an Oblique Circle, perpendicular to a given Oblique Circle.*

The Rule. 1. Find the two Poles of the given Oblique Circle, by *Prob.* 1. *Caſe* 3. of *Spheric Geometry*, in pages 111 and 112.

2. Through thoſe Poles draw a Great Circle, which will cut the Oblique Circle at Right Angles, and the Primitive Circle diametrically oppoſite, and 'tis done.

Example. *Plate* 3. *Fig.* 10.

BCDE the Primitive } Circle, and { A } its Center given;
BFD the Oblique } { y }

To draw another Oblique Circle perpendicular to the Oblique Circle BFD, is required?

1. Find G, the Interior, and Exterior Pole of the given Oblique Circle BFD, by *Problem* 1. *Caſe* 3. of *Spheric Geometry*, in pages 111 and 112.

2. Through G, draw the Circle HIGK, to cut the Primitive in H and K, and the Oblique Circle BFD in I, (ſo that HAK is in a Diameter) and 'tis done, for then the Angle BIH is a right Angle, and the Oblique Circles BFID, and HIGK, are perpendicular to one another.

Note; 1. If the Punct I (on the given Oblique Circle) i given; then draw a Circle through I, (and the Interior Pole G, (by *Problem* 4. of *Spheric Geometry*, in page 113.) and 'tis done.

Or, 2. If it be required, that the ſaid Oblique Circle ſhall make a certain Angle at the Primitive Circle, then draw a Circle through the ſaid Pole G, by *Prob.* 3. of *Spheric Geometry*, in page 113.

Problem VI. *To lay any Quantity of Degrees on any Great Circle.*

In this *Problem* are three Caſes.

Problem VI. Caſe 1. *To lay any Quantity of Degrees on th Primitive Circle.*

The Rule. This is done by, or from the Scale of *Chords*.

Example. *Plate* 3. *Fig.* 8.

BCDE the Primitive Circle, and A its Center given;

To lay 40d. 30m. on the Primitive Circle from B is required?

From the Scale of *Chords*, take 40d. 30m. and lay it on the Primitive Circle from B to C, and 'tis done.

Problem VI. Caſe 2. *To lay any Quantity of Degrees on a Right Circle.*

The Rule. This is done from the Scale of Half-Tangents, counting the Beginning thereof to be the Center of the Primitiv Circle.

Exampl

Example. *Plate* 3. *Fig.* 8.

CDE the Primitive Circle; and A its Center } given ;
AD is a Right Circle ——————— }
n the Right Circle BAD, from A, to lay 40d. 30m. or from B to lay 49d. 30m. is required?

From the Half-Tangents, take 40d. 30m. and lay it on the ight Circle, BAD from A to *l*, or 49d. 30m. the contrary ay of the Half-Tangents, laid from B to *l*, and 'tis done: For *l* and *l*B together are equal to 90 Degrees.

Problem VI. Caſe 3. *To lay any Quantity of Degrees on an Oblique Circle.*

The Rule. 1. Find the Poles of the given Oblique Circle, by *roblem* 1. *Caſe* 3. of *Spheric Geometry*, in pages 111 and 112.

2. Lay the given Quantity of Degrees on the Primitive Circle, y *Caſe* 1. of this *Problem.*

3. Reduce it from the Primitive Circle to the given Oblique ircle, by laying a Scale on either of its Poles, and 'tis done.

Example. *Plate* 3. *Fig.* 11.

BCDE the Primitive } Circle, and { A } its Center given,
BIFD an Oblique — } { y }
n the Oblique Circle BFD (from B) to lay 51d. 30m. is reired?

1. By A and y, draw the Diameter CAE, and find G the ole of the Oblique Circle, by *Prob.* 1. *Caſe* 3. in page 111.

2. From the Scale of *Chords*, take 51d. 30m. and lay it on the rimitive Circle, from B to H.

3. Lay a Scale on G and H, to cut the Oblique Circle) BFD I, then is BI (on the Oblique Circle) equal to 51d. 30m. as as required.

Problem VII. *To meaſure any Part of a Great Circle.*

In this Problem are three *Caſes*, which are but the converſe of oſe in the laſt Problem.

roblem VII. Caſe 1. *To meaſure any Part of the Primitive Circle*

The Rule. Take the Part required to be meaſured, and lay it the Scale of *Chords*, and it ſheweth how much it is.

Example. *Plate* 3. *Fig.* 8.

CDE the Primitive Circle, and A its Center given;
To meaſure BC, a Part of the Primitive Circle, is required?
Take the Extent BC in the Compaſſes, and lay it on the *Chords*, hich will ſhew how many Degrees BC doth meaſure.

Problem VII. Caſe 2. *To meaſure any Part of a Right Circle*

The Rule, 1. If the Part to be meaſured lieth next the Center of the Primitive Circle, then 'tis meaſured on the Scale of Half-Tangents, from the Braſs Center Pin at the Beginning thereof.

2. When the Part to be meaſured lieth next to the Primitive Circle, then 'tis meaſured on the Scale of Half-Tangents, from 90d. counting 80d. to be 10d. 70 to be 20, 60 to be 30, &c.

Example. *Plate* 3. *Fig.* 8.

BCDE the Primitive Circle, and A its Center } given;
BAD a Right Circle ——————— }

To Meaſure *Al*, or *Bl*, on the Right Circle *BAD*, is required?

1. Take *Al*, and lay it on the Scale of Half-Tangents, from the Braſs Center Pin (at the Beginning of it) which will ſhew how many Degrees it is: Or,

2. Take *Bl*, and lay it on the Scale of Half-Tangents from 90d. backwards, counting 80d. to be 10, and 70 to be 20, &c. which will ſhew how many Degrees *Bl*, is: And,

Note, That *Al*, and *Bl*, will make together juſt 90d. they being Complements to each other.

Prob. VII. Caſe 3. *To meaſure any Part of an Oblique Circle.*

The Rule. 1. Find the Poles of the given Oblique Circle, by *Problem* 1. *Caſe* 3. of *Spheric Geometry*, in *Pages* 111 and 112.

2. Lay a Scale on either of the ſaid Poles, and the Part deſired to be meaſured, and reduce it to the Primitive Circle.

3. Being thus reduced to the Primitive Circle, 'tis meaſured on the Scale of Chords, as before in *Caſe* 1. of this *Problem.*

Example. *Plate* 3. *Fig.* 11.

BCDE the Primitive } Circle, and { A } its Center given.
BIFD an Oblique } { y }

To meaſure BI, and FI, on the Oblique Circle BIFD is required?

4. Find G the Pole of the Oblique Circle BIFD, by *Prob.* 1. *Caſe* 3. of *Spheric Geometry*, in *Pages* 111 and 112.

2. Lay a Scale on G and I, to cut the Primitive Circle in H.

3. Then

en EH meaſured on the Scale of Chords is the Meaſure nd BH on the ſame Scale of Chords is the Meaſure of BI.

roblem VIII. *To meaſure any Spheric Angle.*

In this *Problem* are *four Caſes*; and this is *ral Rule.* A *Spheric Angle* is meaſured by the Arc of ircle, intercepted between the two containing Sides, the unct being the Pole of that Circle: Or the Diſtance of of the containing Sides, is equal to the Meaſure of the Angle.

I. Caſe 1. *To meaſure an Angle, when its Angular Punct is the Center of the Primitive Circle.*

e. Such an Angle is meaſured (like a Plane Angle) on ve Circle, by a Scale of Chords.

Example. *Plate* 3. *Fig.* 8.

Primitive Circle, A its Center, and the Angular Punct en; to meaſure the Angle BAC is required?

, and meaſure it on the Scale of Chords, ſhews the , how much it is.

Caſe 2. *To meaſure an Angle, when its Angular Punct is at the Primitive Circle.*

1. Find the Poles of the two containing Sides, by of *Spheric Geometry*, in Pages 111 and 112.

Diſtance of theſe two Poles, is the meaſure of the gle.

When the two Poles are in one Diameter, or Right meaſured on the Scale of Half-Tangents.

they are not in one Diameter, then reduce them to e Circle, by laying a Scale on the Angular Punct, two Poles, which Diſtance being meaſured, on the rds, is the Meaſure of the required Angle.

Example. *Plate* 3. *Fig.* 8.

ne Primitive } Circle, and { A } its Center given.
an Oblique } { y }

re the Angle EDF, *equal to the Angle* EBF *is required.*

ough A and y, draw a Diameter to cut the Primitive . H and I, and the Oblique Circle in G.

the Diameter IAH, find K, the Pole of the Oblique EGFD.

Problem VII. Caſe 2. *To meaſure any Part of a Rig*

The Rule, 1. If the Part to be meaſured lieth next t of the Primitive Circle, then 'tis meaſured on the Scal Tangents, from the Braſs Center Pin at the Beginnin

2. When the Part to be meaſured lieth next to the Circle, then 'tis meaſured on the Scale of Half-Tange 90d. counting 80d. to be 10d. 70 to be 20, 60 to be

Example. *Plate* 3. *Fig.* 8.

BCDE the Primitive Circle, and A its Center } give
BAD a Right Circle ———————— }

To Meaſure *Al,* or *Bl,* on the Right Circle *BAD,* is

1. Take *Al,* and lay it on the Scale of Half-Tang the Braſs Center Pin (at the Beginning of it) which how many Degrees it is: Or,

2. Take *Bl,* and lay it on the Scale of Half-Tan 90d. backwards, counting 80d. to be 10, and 70 to which will ſhew how many Degrees *Bl,* is: And,

Note, That *Al,* and *Bl,* will make together juſ being Complements to each other.

Prob. VII. Caſe 3. *To meaſure any Part of an Obl*

The Rule. 1. Find the Poles of the given Oblique *Problem* 1. *Caſe* 3. of *Spheric Geometry,* in *Pages* 11

2. Lay a Scale on either of the ſaid Poles, and the to be meaſured, and reduce it to the Primitive Circle

3. Being thus reduced to the Primitive Circle, 't on the Scale of Chords, as before in *Caſe* 1. of this *P*

Example. *Plate* 3. *Fig.* 11.

BCDE the Primitive } Circle, and { A } its Ce
BIFD an Oblique } { y }

To meaſure BI, and FI, on the Oblique Circle BIFD .

4. Find G the Pole of the Oblique Circle BIFD, b *Caſe* 3. of *Spheric Geometry,* in *Pages* 111 and 112.

2. Lay a Scale on G and I, to cut the Primitive Circ

3

3. Then EH meaſured on the Scale of Chords is the Meaſure of FI; and BH on the ſame Scale of Chords is the Meaſure of BI.

Problem VIII. *To meaſure any Spheric Angle.*

In this *Problem* are *four Caſes*; and this is

A General Rule. A *Spheric Angle* is meaſured by the Arc of a Great Circle, intercepted between the two containing Sides, the Angular Punct being the Pole of that Circle: Or the Diſtance of he Poles of the containing Sides, is equal to the Meaſure of the contained Angle.

Prob. VIII. Caſe 1. *To meaſure an Angle, when its Angular Punct is the Center of the Primitive Circle.*

The Rule. Such an Angle is meaſured (like a Plane Angle) on he Primitive Circle, by a Scale of Chords.

Example. *Plate* 3. *Fig.* 8.

BCDE the Primitive Circle, A its Center, and the Angular Punct given; to meaſure the Angle BAC is required?

Take BC, and meaſure it on the Scale of Chords, ſhews the Angle BAC, how much it is.

Prob. VIII. Caſe 2. *To meaſure an Angle, when its Angular Punct is at the Primitive Circle.*

The Rule. 1. Find the Poles of the two containing Sides, by *Problem* 1. of *Spheric Geometry*, in Pages 111 and 112.

2. The Diſtance of theſe two Poles, is the meaſure of the equired Angle.

Note 1. When the two Poles are in one Diameter, or Right Circle, 'tis meaſured on the Scale of Half-Tangents.

2. When they are not in one Diameter, then reduce them to he Primitive Circle, by laying a Scale on the Angular Punct, and the ſaid two Poles, which Diſtance being meaſured, on the Scale of Chords, is the Meaſure of the required Angle.

Example. *Plate* 3. *Fig.* 8.

$\left.\begin{array}{l}\text{BCDE the Primitive}\\ \text{BGFD an Oblique}\end{array}\right\}$ Circle, and $\left\{\begin{array}{c}\text{A}\\ \text{y}\end{array}\right\}$ its Center given.

To meaſure the Angle EDF, *equal to the Angle* EBF *is required.*

1. Through A and y, draw a Diameter to cut the Primitive Circle in H and I, and the Oblique Circle in G.

2. In the Diameter IAH, find K, the Pole of the Oblique Circle BGFD.

3. The Diſtance AK, or GI, meaſured on the Scale of Half Tangents, (the latter the contrary Way on that Scale from 90d. ſheweth how much the Angle EDF, or EBF is.

Problem VIII. Caſe 3. *To meaſure an Angle when its Angular Punct is not in the Center of, nor at the Primitive Circle.*

The Rule is this; 1. Find the two Poles of the two containing Sides, by *Problem* 1. in *Pages* 111 and 112.

2. Reduce thoſe two Poles to the Primitive Circle, then meaſure the Diſtance of them on a Scale of Chords, and 'tis done.

Note, *Reduce*, is to lay a Scale on the Angular Punct (required to be meaſured) and the ſaid two Poles, to cut the Primitive Circle.

Example. *Plate* 3. *Fig.* 8.

BCDE *the Primitive* } *Circle, and* { A } *its Center* —— } given
BGED *an Oblique* y }
CAFE *a Right* *cuts the Oblique in* F.

To meaſure the Angle DFE, *or* BFE *is required?*

1. Through A and y, draw the Diameter IAH, and in it find K the Interior Pole of the Oblique Circle BGFD, as before in the laſt Caſe.

2. Find L the Pole of the Right Circle CAFE, by *Problem* 1. *Caſe* 2. of *Spheric Geometry*, in *Page* 111.

3. Reduce K to the Primitive Circle (by laying a Scale on F and K, to cut the Primitive Circle) and 'tis M; Then L M meaſured on the Chords, ſheweth how much the Angle DFE, or BFE, is; one Acute, and the other Obtuſe.

Problem VIII. Caſe 4. *To meaſure an Angle, when the containing Sides are both Oblique Circles.*

Example. *Plate* 3. *Fig.* 12.

BCDE *the Primitive* } *Circle, and* { A
CHFE *an Oblique* y } *its Center given;*
BGFD *an Oblique* x

To meaſure the Angle DFE, *or* BFE *is required?*

1. By A and y; and A and x, draw two Diameters; in them find I and K, the two Interior Poles of the containing Sides, by *Problem* 1. *Caſe* 3. of *Spheric Geometry*, in *Pages* 111 and 112.

2. Reduce thoſe two Poles, I and K, (by laying a Scale on the Angular Punct F, and them) to cut the Primitive Circle in L and M; which being meaſured on the Chords, ſheweth how much the Angle DFE, or BFE, is; one Acute, the other Obtuſe.

Problem

Problem IX. *To draw a Parallel Circle.*

Definition. A Parallel Circle or a leſſer Circle, cutteth the phere into two unequal Parts, and lieth parallel to a Great Circle.

In this *Problem* are three *Caſes.*

roblem IX. Caſe 1. *To draw a Circle parallel to the Primitive Circle, at any given Diſtance from it, or from its Pole.*

The Rule. With the Half-Tangent of its Diſtance from the ole, and one Foot on the Center of the Primitive Circle, draw Circle, and 'tis done.

Example. *Plate* 3. *Fig.* 7.

BCDE the Primitive Circle, A its Center given; to draw a ircle parallel to BCDE, at 30d. diſtance from it, is required?

With the Half-Tangent of 60d. (the Complement of 30d. and) ts Diſtance from the Pole of the Primitive Circle) ſet one Foot n A (the Center, and Pole of the Primitive Circle) and decribe the Circle *t m n o*, which is parallel, as required?

Problem IX. Caſe 2. *To draw a Circle parallel to a Right Circle.*

The Rule. 1. From the Chords lay the Parallel's Diſtance rom the Right Circle, or the Complement thereof, from one of e Poles of the Right Circle, both Ways, and note thoſe two arks on the Primitive Caſe.

2. With the Tangent of the parallel's Diſtance from the Pole f the Right Circle, and one Foot on each of thoſe two Marks, eſcribe Arcs to cut each other, in the Center of the Parallel ircle required to be drawn.

Example. *Plate* 3. *Fig.* 7.

BCDE the Primive Circle, and A its Center } given;
BAD is a Right Circle ——————— }

o draw a Circle parallel to BAD, *at* 40d *diſtance from it, or* 50d. *Diſtance from* C, *its Pole is required?*

1. Lay 40d from B to *p*, and from D to *q*; or lay its Comement 50d. from C, one of the Poles of the Right Circle both ays to the ſaid *p* and *q*.

With the Tangent of 50d. and one Foot on $\left\{\begin{matrix} p \\ q \end{matrix}\right\}$ make e Arc *y*; which Point of Interſection at *y*, is the Center of the arallel Circle *prq*, required to be drawn.

Problem IX. Caſe 3. *To draw a Circle parallel to an Oblique Circle.*

The Rule. 1. Find the Interior Pole of the given Oblique Circle, by *Problem* 1. *Caſe* 3. in *Pages* 111 and 112, which reduce to the Primitive Circle, and therefrom lay the Parallels diſtance from the Pole both Ways, which being reduced to the Right Circle, is the Diameter of the parallel Circle.

2. Find the middle of the ſaid Diameter, which is the Center of the parallel Circle paſſing through thoſe Marks, and 'tis done.

Example. *Plate* 3. *Fig.* 11.

BCDE the Primitive } Circle and { A } its Center given.
BFD the Oblique } { y }

To draw a Circle parallel to BFD, at 40d. Diſtance from it, or 50d. Diſtance from its Pole is required?

1. Find G the Pole of the given Oblique Circle BFD, by *Problem* 1. *Caſe* 3. of *Spheric Geometry*, in Pages 111 and 112.

2. Meaſure AG on the Half Tangents, and ſuppoſe it to be 30d. then add 50 to it, and ſubtract it from 50; the Sum 80d. Lay from A to *k*; and the Difference 20d. lay from A to *c*: Or, thus; reduce G to the Primitive Circle, and from it lay 50d. both Ways, which reduce to the Right Circle, gives the ſame Point *k* and *c*.

3. Find *m* the middle between *k* and *c*, and on *m* as a Center, draw a Circle to paſs through *k* and *c*, which is the parallel Circle required to be drawn.

Thus much for *Problems* neceſſary for making and meaſuring *Spheric Triangles*; which I adviſe the Learner perfectly to acquaint himſelf with, and then the following Applications will be the better underſtood.

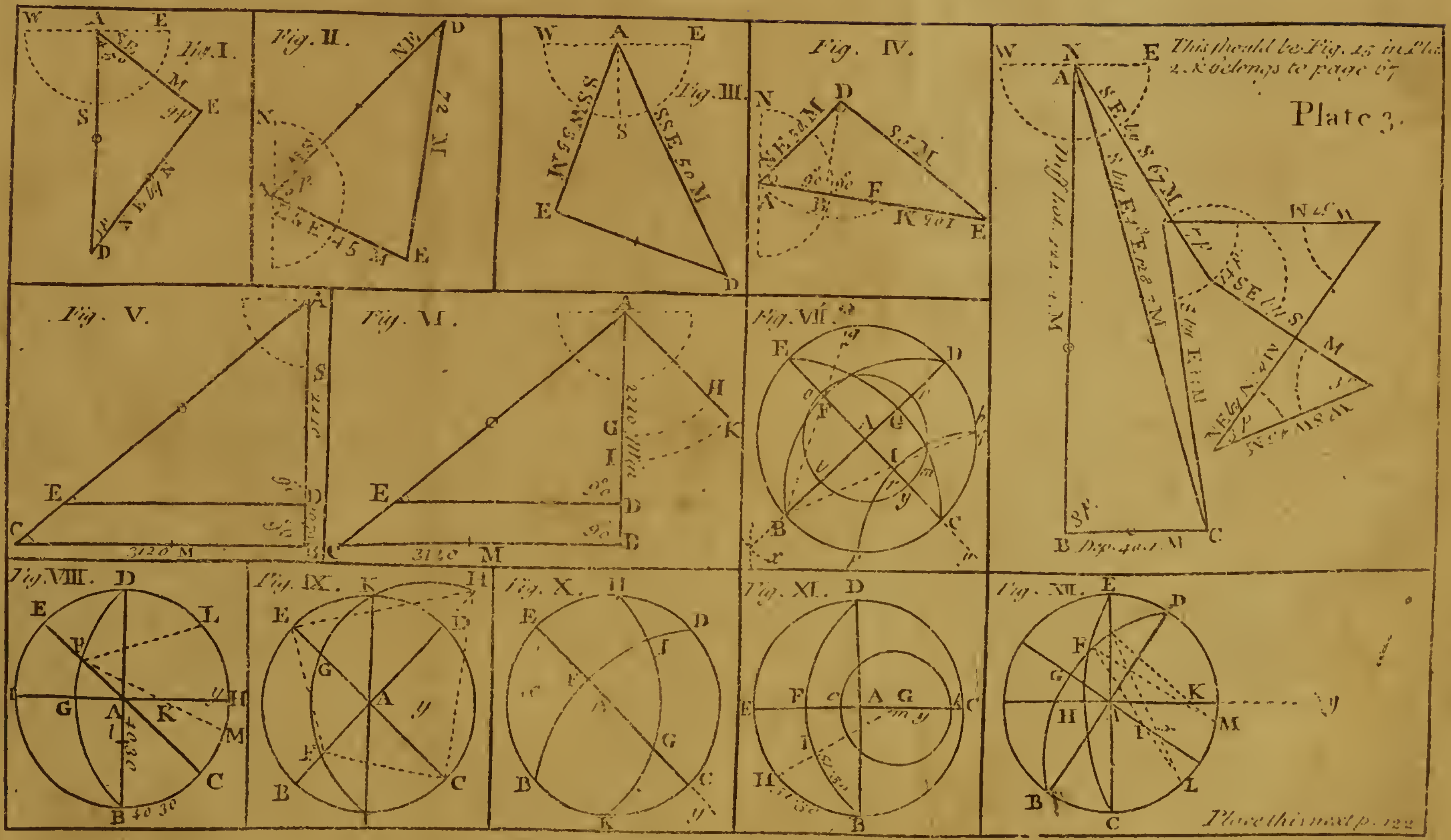
Section II. *The Uſe of the Nine preceeding Problems, in making any* Spheric Triangle, *and meaſuring its Parts, or the Doctrine of* Spheric Triangles-Geometric.

Definition 1. A Sphere or Globe, is a round Body made by the moving a Semi-circle about its own Diameter, 'till the Motion end where it firſt began: The Semicircle's Diameter is the Axis or Diameter of the Sphere; in the middle of which is a Punct, called the Center, from whence all Right Lines drawn to the Surface, or Outſide of the Sphere, are equal.

2. A *Spheric Triangle*, is deſcribed on the Surface of the Sphere, whoſe Sides are the Arcs of three Great Circles, mutually

Plate 3.

This ſhould be Fig. 15 in Pla. 2. & belongs to page 67



Place this next p. 122

utually interſecting each other; and is either Quadrantal, ectangular, or Obliquangular.

. { A Quadrantal / A Rectangular / An Obliquangular } Triangle hath { one Side / one Angle } 90d. / no Side a Quadrant,
r 90d. nor any Angle 90d.

Note 1. In every Spheric Triangle, each Side is leſs than a emicircle, or 180 Degrees.

2. The Sum of any two Sides is greater than the third Side.

3. The three Sides added together, their Sum is leſs than 360 legrees.

4. The Sum of the three Angles, is ever more than two ight Angles, or 180d. but always leſs than ſix Rights, or 540 egrees.

roblem X. *The Hypotenuſe, and one Leg given; to make a Rectangular Spheric Triangle.*

Note, To make a Rectangle Spheric Triangle, two Things, (beſides the Rectangle) muſt be given.

Example. *Plate* 4. *Fig.* 1.

The { Hypotenuſe AC 54d. 25m. / Leg BC —— 23d. 29m. } given;

With them to make a Rectangular Spheric Triangle is required?

1. Draw the Primitive Circle with the Chord of 60d. a Sine of od. or with a Half-Tangent of 90d. and quarter it, which uſt be done in every *Problem*.

Then conſider, whether one of the Oblique Angles ſhall be at e Primitive Circle, or at its Center.

Firſt, If at the Center of the Primitive Circle, then

1. Draw (by *Problem* 9. *Caſe* 1. of *Spheric Geometry*) a Circle rallel to the Primitive, at 54d. 25m. (the given Hypotenuſe) iſtance from its Pole; that is, with the Half-Tangent of d. 25m. and one Foot on A (the Center of the Primitive Cir-e) deſcribe a Circle.

2. Then (by the 2d *Caſe* of the aforeſaid *Problem*) draw a ircle parallel to a Right Circle, at 23d. 29m. (the given Leg) ſtance from it; theſe two parallel Circles cut each other in C.

3. Through A and C, draw a great Circle, which in this ſe is a Right Circle, that is, a Diameter; And from C (by *roblem* 5. *Caſe* 1. of *Spheric Geometry* in *Page* 115.) draw a Great

a Great Circle, perpendicular, or at Right Angles to AB, which in this *Caſe* will be an Oblique Circle, and 'tis done.

Or,

Secondly, To make the Triangle, that one of its Oblique Angles may be at the Primitive Circle.

1. The Circle being deſcribed, and quartered as before directed; Then,

2. Draw (by *Problem* 9. of *Spheric Geometry*) a Circle parallel to a Right Circle, at 54d. 25m. diſtant from A its Pole.

3. And by the aforeſaid *Problem* draw a Circle parallel to the Primitive Circle, at 23d. 29m. diſtant from it, that is, take 66d. 31m. from the Scale of Half-Tangents, and with one Foot on the Center draw a Circle, to cut the former Parallel Circle in C.

4. Then through A and C draw a Great Circle, which in this *Caſe* will be an Oblique Circle; and from C (by *Problem* 5. *Caſe* 1. of *Spheric Geometry*, in page 114.) draw a Great Circle perpendicular to AB; which in this *Caſe* will be a Right Circle, and 'tis done.

To meaſure the Things required.

The { Leg AB ——— is } meaſured } 7. page 117.
{ Angles BAC and ACB are } by *Prob.* } 8. page 118, 119.

Problem XI. *The Hypotenuſe and one Angle given, to make a Triangle.*

Example. *Plate* 4. *Fig.* 2.

The { Hypotenuſe AC 54d. 25m. } given;
{ Angle BAC — 29d. 30m. }

With them to make a Rectangular Spheric Triangle, is required?

Firſt, To make the Triangle, that the given Angle BAC may be at the Primitive Circle's Center.

1. Having deſcribed the Primitive Circle, and quarter'd it, as before directed in *Problem* 10. make the Angle BAC equal to 29d. 30m. (by *Problem* 2. *Caſe* 1. in page 112. of *Spheric Geometry*) that is, from the Scale of Chords, lay 29d. 30m. on the Primitive Circle, and therefrom draw a Line through A, the Center of the Primitive Circle.

2. Make AC equal to 54d. 25m. (by *Problem* 6. *Caſe* 2. in page 116. of *Spheric Geometry*) that is, from the Scale of Half-Tangents; lay 54d. 25m. from A to C.

3. By *Problem* 5. *Caſe* 3. in page 115. draw a Great Circle thro'

C,

, perpendicular unto AB, to cut the Right Circle AB in B; hich in this *Caſe* is an *Oblique Circle*, and 'tis done.

Secondly, To make the Triangle ſo, that the given Angle may at the Primitive Circle.

1. After the Primitive Circle is made, and quarter'd as before, t A be one of thoſe Marks or Quarters; then (by *Problem* 2. *aſe* 2. in page 112.) make the Angle at A equal to 29d. 30m. drawing an Oblique Circle with the Secant of the given Angle, is the Oblique Circle AC.

2. Then (by *Problem* 6. *Caſe* 3. in page 117.) lay 54d. 25m. the Oblique Circle from A to C; Or draw (by *Problem* 9. *aſe* 2. in page 121.) a Circle parallel to a Right Circle at 54d. 5m. diſtant from A its Pole, to cut the Oblique Circle AC C.

3. By *Problem* 5. *Caſe* 1. in page 114, draw a Circle from , perpendicular to the Primitive Circle AB, to cut AB, in B; hich in this *Caſe* is a Right Circle, and 'tis done.

To meaſure the Things required.

he { Legs AB, and BC are / Angle ACB —— is } meaſured by *Prob.* { 7. / 8. } page 117. / page 119.

rob. XII. *A Leg, and its adjacent Angle given; to make a Triangle.* Example. *Plate* 4. *Fig.* 3.

The { Leg AB —— 50d. 30m. / Angle BAC 29d. 30m. } given;

ith them to make a Rectangle Spheric Triangle is required?

Firſt, To make the Triangle, that the given Angle (BAC) ay be at the Primitive Circle's Center.

1. The Primitive Circle being deſcribed, and quarter'd as fore, and A placed at its Center; then (by *Problem* 2. *Caſe* 1. page 112. of *Spheric Geometry*) make the Angle BAC equal to d. 30m. by drawing the Right Circle AC.

2. By *Problem* 6. *Caſe* 2. in page 116. make AB equal to d. 30m. that is, from the Scale of Half-Tangents, lay 50d. m. on the Right Circle from A to B.

3. By *Problem* 5. *Caſe* 3. in page 115. draw through B, an blique Circle BC, perpendicular to the Right Circle AB, to cut e Right Circle AC in C, and its done. Or thus,

From the Scale of Secants, take 39d. 30m. (the Complement AB 50d. 30m. (ſetting one Foot in B, the other Foot marks t (on the Right Circle AB extended) the Center of the Oblique ircle BC, which concludes the Triangle.

Secondly, To make the Triangle ſo, that the given Angle may at the Primitive Circle.

1. A being on, or at the Primitive Circle, then by *Problem* 2 *Caſe* 2. in *Page* 112.) make the Angle BAC equal to 29d. 30m by drawing the Oblique Circle AC, with the Secant thereof.

2. By *Problem* 6. *Caſe* 1. in Page 116. makes AB (on th Primitive Circle) equal to 50d. 30m. by laying the Chord of i from A to B.

3. By *Problem* 5. *Caſe* 1. in *Page* 114. draw a Great Circl from B, perpendicular to AB, as the Right Circle BC, to cu the Oblique Circle AC in C, and 'tis done.

To meaſure the Things required.

The { Leg BC, and Hypot. AC are } meaſured by *Prob.* { 7.
  Angle ACB ——— ——— is } { 8.
in *Pages* 118 and 120.

Problem XIII. *A Leg and its oppoſite Angle given; to make Triangle.*

Example. *Plate* 4. *Fig.* 2.

The { Leg BC —— 23d. 29m. } given;
  Angle BAC 29d. 30m. }

With them to make a Rectangular Spheric Triangle is required

Firſt, To make the Triangle, with the given Angle at th Primitive Circle's Center.

1. The Primitive Circle drawn, *&c.* as before, and A at it Center, (by *Problem* 2. *Caſe* 1. in *Page* 112.) make the Angl BAC equal to 29d. 30m. by drawing two Right Circles AB, and AC.

2. Draw (by *Problem* 9. *Caſe* 2. in *Page* 121.) a Parallel Circle, parallel to the Right Circle AB, at 23d. 29m. diſtance from it, to cut AC in C.

3. From C (by *Problem* 5. *Caſe* 3. in *Page* 115) draw a Oblique Circle BC, perpendicular to the Right Circle AB to cu AB in B, and 'tis done.

Secondly, to make the Triangle, that the given Angle may b at the Primitive Circle.

1. A, being at the Primitive Circle, (by *Problem* 2. *Caſe* 2. i *Page* 112.) make the Angle BAC equal to 29d. 30m. by drawing the Oblique Circle AC, with the Secant thereof.

2. By *Problem* 9. *Caſe* 1. in *Page* 121. draw a Parallel Circle, parallel to the Primitive Circle AB at 23d. 29m. diſtance from it, to cut the Oblique Circle AC in C: Or thus, with the Half-Tangent of 66d. 31m. (the Complement of 23d. 29m.) and one Foot in the Center of the Primitive Circle, with the other cut the Oblique Circle in C.

3. From C (by *Problem* 5. *Caſe* 1. in *Page* 114. draw a Right

ircle BC, perpendicular to the Primitive Circle AB, to cut AB B, and 'tis done.

To meaſure the Things required.

he $\left\{\begin{array}{l}\text{Hypot. AC, and Leg AB, are}\\ \text{Angle ACD ———— is}\end{array}\right\}$ meaſured by *Prob.* $\left\{\begin{array}{l}7.\\ 8.\end{array}\right\}$ n pages 117, 118 and 119.

Problem XIV. *Both Legs given; to make a Spheric Triangle.*

Example. *Plate* 4. *Fig.* 5.

The $\left\{\begin{array}{l}\text{AB 50d. 30m.}\\ \text{BC 23d. 29m.}\end{array}\right\}$ given;

Vith them to make a Rectangular Spheric Triangle is required?

Firſt, To make the Triangle, that one of the Oblique Angles ay be at the Primitive Circle's Center.

1. A, being at the Center of the Primitive Circle, draw the ight, Circle AB, and thereon (by *Problem* 6. *Caſe* 2. in page 16.) make AB equal to 50d. 30m. by laying the Half-Tangent ereof from A to B.

2. From B (by *Problem* 5. *Caſe* 3. in *Page* 115.) draw an blique Circle BC perpendicular to AB: Or thus,

With the Secant of 39d. 30m. (the Complement of 50d. 30m.) nd one Foot on B, the other Foot marks out (in the Right ircle AB extended) the Center of the Oblique Circle BC.

3. Draw (by *Problem* 9. *Caſe* 2. in *Page* 121.) a Parallel ircle, parallel to the Right Circle AB, at 23d. 29m. diſtance om it, to cut the Oblique Circle BC in C: or thus,

By *Problem* 6. *Caſe* 3. in *Page* 117. lay 23d. 29m. on the blique Circle, from B to C.

4. Through A and C draw a Great Circle; which in this Caſe a Right Circle, and 'tis done.

Secondly, To make the Triangle, that one of the Oblique ngles may be at the Primitive Circle.

1. By *Problem* 6. *Caſe* 1. in *Page* 116. make AB equal to 50d. om. by laying the Chord thereof on the Primitive Circle, from to B.

2. From B (by *Problem* 5. *Caſe* 1. in *Page* 114) draw a reat Circle perpendicular to the Primitive Circle, which in this aſe is a Right Circle) as BC.

3. Draw (by *Problem* 9. *Caſe* 1. in *Page* 121.) a Parallel Cir-le, parallel to the Primitive Circle AB, at 23d. 29m. diſtance om it, to cut the Right Circle BC in C: Or thus,

From the Scale of Half-Tangents, lay 66d. 31m. (the Com-lement of 23d. 29m.) from the Center of the Primitve Circle, n the Right Circle to C.

4. Through A and C, draw a Great Circle; which in this *Caſe* is an *Oblique Circle*, and 'tis done.

To meaſure the Things required.

The { Hypotenuſe AC —— is / Angles BAC, and ACB are } meaſured by Problem { 7. / 8. } in pages 117, 118, 119.

Problem XV. *Both the Angles given; to make a Spheric Triangle.*

Example. *Plate* 4. *Fig.* 6.

The Angle { BAC 29d. 30m. / ACB 71d. 56m. } given;

With them to make a Rectangle Spheric Triangle is required;

1. By *Problem* 2. *Caſe* 2. in page 112, make the Angle BAC equal to 29d. 30m. by drawing the *Oblique Circle* AB, with the Secant thereof.

2. Find I, the Pole of the *Oblique Circle* A B, by *Problem* 1. *Caſe* 3. in pages 111 and 112.

3. Through I (by Problem 3. in page 113.) draw an *Oblique Circle* IBC, that the Angle ACB may be 71d. 56m. which will cut the *Oblique Circle* AB in B the Rectangle, and the Primitive Circle in C, and ſo conclude the Rectangle Spheric Triangle ABC, required to be made.

To meaſure the Things required.

The Hypotenuſe AC, and Legs AB, and AC, are meaſured by Problem 7. of *Spheric Geometry*, in pages 117 and 118.

Thus, All the *Caſes* of Rectangular Spheric Triangles may be deſcribed, and reſolved by the laſt Six Problems: In like manner, the *Caſes* of Oblique Spheric Triangles may be Geometrically ſolved by the Six following.

Problem XVI. *Two Sides, and an Angle oppoſite given; to make an Oblique Spheric Triangle.*

Note; To make an Oblique Spheric Triangle, three Things muſt be given.

Note alſo, The Angle oppoſite to the other given Side ought to be foreknown, whether Acute or Obtuſe; otherwiſe two ſeveral Triangles may be made from the given Things.

Example. *Plate* 4. *Fig.* 7.

The { Side —— AC 34d. 07m. / Side —— AD 65d. 20m. / Angle ADC 27d. 30m. } given;

With them to make a Spheric Triangle (ſo the Angle ACD may be Obtuſe) is required?

1. On the Primitive Circle, make AD (the given Side joining the given Angle) equal to 65d. 20m. by Problem 6. Caſe 1. f Spheric Geometry, in page 116.

2. By Problem 2. Caſe 2. in page 112. make the Angle ADC qual to 27d. 30m. by drawing the Oblique Circle DC, with ne Secant thereof.

3. Draw (by Problem 9. Caſe 2. in page 121) a Parallel ircle at 34d. 07m. diſtance from A, to cut the Oblique Circle C, in C.

4. Through A and C, draw a great Circle, and 'tis done.

To meaſure the Things required.

he { Angles CAD, and ACD are / Side CD ———— is } meaſured by Prob. { 8. / 7. } Pages 118 and 119.

roblem 17. *Two Angles, and one Side oppoſite given; to make an Oblique Spheric Triangle.*

Example. *Plate* 4. *Fig.* 8.

The { Angle CAD 30d. 48m. / Angle ADC 27d. 30m. / Side CD — 38d. 28m. } given;

With them to make an Oblique Spheric Triangle, ſo that the ide AC may be leſs than a Quadrant, or 90d. is required?

1. By Prob. 2. Caſe 2. in page 112. make the Angle ADC ual to 27d. 30m. (always the Angle joining to the given Side) drawing the Oblique Circle DC, with the Secant of it.

2. Draw (by Prob. 9. Caſe 2. in page 121.) a parallel Circle 38d. 28m. diſtance from D, to cut the Oblique Circle DC, C.

3. Then through C (by Prob. 3. in page 113.) draw a great ircle to make an Angle at the Primitive Circle that may be equal 30d. 48m. as is the Oblique Circle CA, and it's done.

To meaſure the Things required.

The { Side AC, and AD are / Angle ACD ——— is } meaſured by Prob. { 7. / 8. } pages 118 and 119.

Note; In theſe two laſt Problems, the three given Things witht the Quality of a Fourth, are not ſufficient to determine the riangle; And the Quality of the Fourth is not always diſcoverle by the given Things; therefore they are called *Doubtful Caſes.*

rob. 18. *Two Sides and one Angle between them given; to make an Oblique Spheric Triangle.*

Example. *Plate* 4. *Fig.* 9.

The { Side ——— AC 34d. 06m.
Side ——— AD 65d. 20m.
Angle — CAD 30d. 46m. } given;

With them to make an *Oblique Spheric Triangle* is required?

1. By *Problem* 2. *Caſe* 2. in *Page* 112. make the Angle CAD equal to 30d. 46m. by drawing the *Oblique Circle* AD with the Secant thereof.

2. Make AC (on the Primitive Circle) equal to 34d. 06m. and AD (on the *Oblique Circle)* equal to 65d. 20m. by *Problem* 6. *Caſe* 1 and 3. in *Pages* 116 and 117.

3. Through C and D, draw a Great Circle and 'tis done.

To meaſure the Things required.

The { Side ———CD——— is
Angles ACD, and ADC are } meaſured by *Problem* { 7.
8. }
in *pages* 118 and 119.

Problem 19. *Two Angles, and one Side between them given; to mak an Oblique Spheric Triangle.*

Example. *Plate* 4. *Fig.* 10.

The { Angle ACD 131d. 34m.
Angle ADC 27d. 30m.
Side — CD 38d. 28m. } given;

With them to make an *Oblique Spheric Triangle* is required?

1. On the Primitive Circle, make CD equal to 38d. 28m. the given Side, by *Problem* 6. *Caſe* 1. in *Page* 116.

2. At D (by *Prob.* 2. *Caſe* 2. in *Pages* 112 and 113) make th Angle ADC equal to 27d. 30m. by drawing the *Oblique Circle* DA and at C, make the Angle ACD equal to 131d. 34m. by drawin the *Oblique Circle* AC, and 'tis done.

To meaſure the Things required.

The { Sides AC, and AD are
Angle CAD ——— } meaſured by *Prob.* { 7.
8. } in
Pages 118 and 119.

Problem 20. *Three Sides given; to make an Oblique Spheric Triangl*

Example. *Plate* 4. *Fig.* 11.

The Side { AD 65d. 20m.
CD 38d. 26m.
AC 34d. 08m. } given;

With them to make an *Oblique Spheric Triangle* is required?

1. On the *Primitive Circle* make AD equal to 65d, 20m. (th greater given Side) by *Prob.* 6. *Caſe* 2. in *Page* 116.

2. Draw (by *Prob.* 9. *Caſe* 2. in *Page* 121.) a Parallel Circle at 34d. 08m. diſtance from A; and likewiſe another at 38d. 26m diſtance from D, to cut each other in C.

3. Throug

3. Through A and C, and alſo D and C, draw Great Circles, ich will form the Spheric Triangle required.

To meaſure the Things required.

1. Find (by Problem 1, in pages 111 and 112.) the Poles of e three Sides of the Triangle ACD; that is, E the Pole of AD, the Pole of AC, and G the Pole of CD.

2. Through F and G, draw a Great Circle, of which the an- lar Point C is its Pole, and you will form the Triangle EFG.

3. The Sides of the Triangle EFG, are equal to the Angles of e Triangle ACD; and the Angles of the firſt, are equal to the les of the latter, only the greater Angle in the one, is equal to e Supplement (of the greater Side in the other) to a Semi-circle. That is; the Side EF is equal to the Angle CAD, the Side EG equal to the Angle ADC, and the Side FG is equal to the Sup- ment to 180d. of the Angle ACD.

4. The Sides EF, EG, and FG, are meaſured by Problem 7, pages 117 and 118.

blem 21. *Three Angles given; to make an Oblique Spheric Triangle.*

Example. *Plate* 4. *Fig.* 12.

$$\text{The Angle}\left\{\begin{array}{ll}\text{CAD} & \text{131d. 34m.}\\ \text{ACD} & \text{30d. 45m.}\\ \text{ADC} & \text{27d. 30m.}\end{array}\right\}\text{given;}$$

ith them to make an Oblique Spheric Triangle, is required?

1. Suppoſe a Triangle EFG, whoſe Sides are equal to the An- s of the Triangle ADC; that is, the Side EF equal to 48d. n. the Supplement to 180d. of the Angle CAD equal to 131d. n. and the Side EG equal to the Angle ACD 30d. 45m. and Side FG equal to the Angle ADC 27d. 30m.

2. Then conſtruct the Triangle EFG with the Sides EF, EG FG, as before in the laſt Problem.

3. Find (by Problem 1.) the Poles of the three Sides of the iangle EFG; that is, A the Pole of EF, C the Pole of EG, D the Pole of FG.

4. Through C and D, draw a Great Circle, of which the an- ar Point G is its Pole, which will form the Triangle ACD re- red to be made.

To meaſure the Things required.

he Sides AC, AD, and CD, are meaſured by Problem 7, in es 117 and 118.

hus much I thought neceſſary as preparative to Spheric gonometry by Calculation, that the Learner might know how to make or conſtruct, and meaſure a Spheric Triangle, or any of its Parts; a thing not taught by many, nor well underſtood by more, who pretend to be Teachers, to the great Diſadvantage of the ingenious Scholar.

Section III. *Of the* Affections, *or* Natural Properties *of Spheric* Triangles.

THeſe *Affections* are carefully to be minded, in order to the underſtanding what may be, and what may not be given or required in a Spheric Triangle; and having already given you the ſeveral Definitions of a Sphere, and the Circles of it, with the Kinds of Triangles relative thereto, which I will not here repeat, I paſs on to the *Affections of Spheric Triangles*, as follow.

1. Every Side of a Spheric Triangle is an Arc of a Grea Circle, and is leſs than a Semi-circle.

2. Every Great Circle divides the Sphere or Globe into tw equal Parts or Hemiſpheres.

3. Any two Great Circles cutting each other, the Angl which are oppoſite and contrary, are equal to one another.

4. The Sum of any two Sides (of a Triangle) is greater tha the third Side.

5. The Sum of the three $\left\{\begin{array}{l}\text{Sides}\\ \text{Angles}\end{array}\right\}$ is leſs than $\left\{\begin{array}{l}\text{360d.}\\ \text{540d.}\end{array}\right.$ but more than 180d.

6. Any two Sides added together, their Sum is leſs than th Difference between the third Side and 180d. But,

Any two Angles added together, their Sum is more than th Difference between the third Angle and 180d.

7. In a Rectangular Triangle, the Legs and their oppoſit Angles are of the ſame *Affection*; that is, if a Leg be more, leſs than a Quadrant, its oppoſite Angle it likewiſe more, or le than a Right Angle.

8. In a Rectangular Triangle, if one Leg be a Quadrant, th Hypotenuſe will be a Quadrant; but if both Legs be of th ſame *Affection*, the Hypotenuſe is leſs than a Quadrant; if different, 'tis more; and on the contrary, if each of the Legs leſs, or more than 90d. the Hypotenuſe is leſs than 90d. B if one Leg be more than 90d. and the other leſs, the Hypotenu is more than 90d.

9. If the Hypotenuſe be $\left.\begin{array}{l}\text{leſs}\\ \text{more}\end{array}\right\}$ than 90d. one Leg, and

oppoſite Angle will be $\left\{\begin{array}{l}\text{leſs than 90d. the other may, or not}\\ \text{more, and the other leſs than 90d.}\end{array}\right.$

10.

10. If both Angles at the Hypotenuſe are Acute, or Obtuſe, he Hypotenuſe is leſs than a Quadrant; but if one be Acute, ınd the other Obtuſe, the Hypotenuſe is more than a Quadrant.

11. In every Triangle, greateſt Sides are oppoſite to greateſt Angles, and equal Sides to equal Angles.

12. In every Oblique Triangle, two $\left\{\begin{matrix}\text{Acute}\\ \text{Obtuſe}\end{matrix}\right\}$ Angles being equal heir oppoſite Sides are equal, and each $\left\{\begin{matrix}\text{leſs}\\ \text{more}\end{matrix}\right\}$ than a Quadrant

13. If two $\left\{\begin{matrix}\text{Acute}\\ \text{Obtuſe}\end{matrix}\right\}$ Angles are unequal, the Side oppoſite o the $\left\{\begin{matrix}\text{leſſer}\\ \text{greater}\end{matrix}\right\}$ Angle ſhall be $\left\{\begin{matrix}\text{leſs}\\ \text{more}\end{matrix}\right\}$ than a Quadrant.

14. All the Angles Acute, each Side is leſs than a Quadrant.

Theſe Things being premiſed their Solution followeth; and irſt of *Rectangular Spheric Triangles*, in which are 16 Caſes, and hen *Oblique-angled Spheric Triangles*, in which are 12 Caſes.

ection IV. *The Solution of the* 16 *Caſes of* Rectangular Spheric Triangles, *by the Lord* Napier's *Catholic Propoſition.*

1. IN a Rectangular Triangle, there are (beſides the Right-angle) five Things, which the Lord *Napier* calleth the Five cir- ular Parts of a Speric Triangle, amongſt which, the Right-angle ıot being reckoned, the two Legs are ſuppoſed to join together.

2. Any one of theſe five circular Parts, may, (by Suppoſition) e made a middle Part, and then the two Circular Parts, which re next to that middle Part, are the Extremes Conjunct; And he other (two circular Parts) remote from the (aſſumed middle Part) are the Extreams Disjunct.

3. In every Caſe, two of the aforeſaid five circular Parts are always) given, to find a third; of theſe three Things (two given and one required) one is middle Part, and the other two are Extreams, either Conjunct or Disjunct.

The Parts of a Rectangular Triangle being thus diſtinguiſhed, obſerve the Univerſal Propoſition following, invented by the aforeſaid Lord, the Inventor of Logarithms.

The Catholick Propoſition.

The Sine of the middle Part and Radius, are reciprocally proportional with the Tangents of the Extreams Conjunct: and with the Sine Complements of the Extreams Disjunct: That is,

1. For Extreams Conjunct, thus;

As the Radius, is to the Tangent of one Extream; ſo is th Tangent of the other, to the Sine of the middle Part: And,

2. For Extreams Disjunct, thus;

As the Radius, is to the Sine Complement of one Extream, ſ is the Sine Complement of the other, to the Sine of the middl Part: Therefore,

Note; When the middle Part is to be found, the Radius is to b the 1ſt Term in the Proportion, as above; But if either of the Extreams be required, the other Extream muſt be the firſt Term That is,

3. For Extreams Conjunct, thus;

As the Tangent of the given Extream, is to the Radius; ſo i the Sine of the middle Part, to the Tangent of the required Extream: And,

4. For Extreams Disjunct, thus;

As the Sine Complement of the given Extream, is to the Radius; ſo is the Sine of the middle Part, to the Sine Complemen of the required Extream: But,

Note 1. That if the middle Part, or either of the Extream Conjunct be the Hypotenuſe, or either of the Oblique Angles inſtead of Sine, and of Tangent, you muſt uſe the Sine Complement, and Tangent Complement.

A TABLE *of all the* Varieties *of* Extreams Conjunct, *and* Disjunct.

Number.	*Middle Part.*	*Ext. Conjunct.*	*Ext. Disjunct.*
1	Sine AB	Tang. — BC Tang. c. BAC	Sine ACB Sine AC
2	Sine c. BAC	Tang. c. AC Tang. — AB	Sine c. BC Sine ACB
3	Sine c. AC	Tang. c. BAC Tang. c. ACB	Sine c. BC Sine c. AB
4	Sine c. ACB	Tang. c.—AC Tang.——BC	Sine BAC Sine c. AB
5	Sine BC	Tang.——AB Tang. c. ACB	Sine BAC Sine AC

2. If either of the Extreams Disjunct be the Hypotenuſe, or ither of the Oblique Angles, inſtead of Sine Complement, you nuſt uſe the Sine.

And for the eaſier underſtanding theſe Directions, obſerve the oregoing *Table*, wherein are placed the five Circular Parts of a Rectangular Spheric Triangle, under their reſpective Titles, whe- her they be taken for the middle Part, or for Extreams, either Conjunct or Disjunct; and unto thoſe Parts are prefixed, Sine, ine Complement, Tangent, and Tangent Complement; as they ught to be, and are uſed in the *Caſes* following.

roblem 1. Caſe 1, 2 and 3. *The Hypotenuſe, and one Leg, given.*

$$\text{To find}\left\{\begin{matrix}1.\\2.\\3.\end{matrix}\right\}\text{The}\left\{\begin{matrix}\text{Angle adjacent}\\\text{Angle oppoſite}\\\text{Other Leg.}\end{matrix}\right.\left.\begin{matrix}\\\\\end{matrix}\right\}\text{to the given Leg}$$

Example. *Plate* 4. *Fig.* 1.

In the Rectangular Spheric Triangle ABC, there is given,

$$\text{The}\left\{\begin{matrix}\text{Hypot. AC } 54^{d}.\ 25^{m}.\\\text{Leg BC } 23^{d}.\ 29^{m}.\end{matrix}\right\}\left\{\begin{matrix}\text{ACB, BAC}\\\text{and AB —}\end{matrix}\right\}\text{required;}$$

This Triangle is made by *Problem* 10, of *Spheric Trigonometry Jeometric*, in *pages* 123 and 124.

1. For the contained Angle ACB, or Angle adjacent to the iven Leg, the Proportion is;

As the Radius, is to the Tangent of the given Leg; ſo is the Tangent Complement of the Hypotenuſe, to the Sine Comple- nent of the adjacent Angle required. Or thus,

Radius .. T. Leg BC : : T.c Hypot. AC .. S. c. Angle ACB.
T.45^{d}. .. T.23^{d}.29m. : : T. 35^{d}. 35^{m}. .. S. 18d. 07m.
which ſubtract from 90d. reſts 71d. 53^{m}. for the Angle ACB.

Therefore the Extent (on the *Gunter*'s Scale) from Tangent of 45d. to Tangent of 23d. 29m. reacheth from Tangent 35^{d}. 35^{m}. o the Tangent 17d. 15m. againſt which, on the Line of Sines, is 18d. 07m. the 4th Term in the Proportion above,

$$\textit{Note};\ \text{The } \textit{Hyp.} \text{ and given } \textit{Leg}\left\{\begin{matrix}\text{each}\\\text{one}\end{matrix}\right\}\text{more}\left\{\begin{matrix}\text{or —}\\\text{the other}\end{matrix}\right\}\text{leſs}$$

han a Quadrant, or 90d. the required Angle is $\left\{\begin{matrix}\text{Acute.}\\\text{Obtuſe.}\end{matrix}\right.$

2. For the Angle BAC oppoſite to the given Leg, the Propor- ion is thus;

As the Sine of the Hypotenuſe, is to Radius; ſo is the Sine o the given Leg, to the Sine of its oppoſite Angle: Or thus,

S. Hypot. AC ·· Radius : : S. Leg BC ·· S. Angle BAC.

S. 54d. 25m. ·· S. 90d. : : 23d. 29m. ·· Sine 29d. 20m.

Therefore the Extent (on the *Gunter*) from Sine 54d. 25m to Sine of 90d. reacheth from Sine of 23d. 29m. to Sine of 29d 20m. the fourth Term in the Proportion aboveſaid.

Note, The given Leg $\left\{\begin{matrix}\text{leſs}\\ \text{more}\end{matrix}\right\}$ than a Quadrant, or 90d.

the required Angle is $\left\{\begin{matrix}\text{Acute.}\\ \text{Obtuſe.}\end{matrix}\right.$

4. For the Leg AB, the Proportion is thus;

As the Sine Complement of the given Leg, is to Radius; ſ is the Sine Complement of the Hypotenuſe, to the Sine Com plement of the required Leg: Or thus;

S.c. Leg BC ·· Radius : : S.c. Hyp. AC ·· S. c. Leg AB.

S. 66d. 31m. ·· S. 90d. : : S. 35d. 35m. ·· S. 39d. 23m.

which ſubtract from 90d. reſteth 50d. 37m. for the Leg A required.

Therefore the Extent (on the *Gunter's-Scale*) from the Sine c 66d. 31m. to Sine of 90d. will reach from Sine of 35d. 35m. t Sine of 39d. 23m. the fourth Term in the Proportion aforeſaid.

Note, The Hypot. and given Leg of $\left\{\begin{matrix}\text{one ——}\\ \text{a different}\end{matrix}\right\}$ Kind,

the required Leg is $\left\{\begin{matrix}\text{leſs}\\ \text{more}\end{matrix}\right\}$ than a Quadrant.

Problem 2. Caſe 4, 5, and 6:

The Hypotenuſe, and one Angle given;

To find $\left\{\begin{matrix}\text{1.}\\ \text{2.}\\ \text{3.}\end{matrix}\right\}$ the $\left\{\begin{matrix}\text{Leg oppoſite}\\ \text{Leg adjacent}\\ \text{other Angle.}\end{matrix}\right.$ $\left.\begin{matrix}\\ \\ \end{matrix}\right\}$ to the given Angle

Example. *Plate* 4. *Fig.* 2.

In the Rectangular Spheric Triangle ABC, there is given; $\left\{\begin{matrix}\text{Hypot. AC 54d. 25m.}\\ \text{Angle BAC 29d. 30m.}\end{matrix}\right\}$ Leg BC, AB, and Angle ACB required?

This Triangle is made by Problem 11. of *Spheric Trigonome try Geometric*, in pages 124 and 125.

1. For the Leg BC, oppoſite to the given Angle, the Propo tion is thus;

As Radius, is to the Sine of the Hypotenuſe; ſo is the Sine the given Angle, to the Sine of its oppoſite Leg required: C thus.

Radiu

Radius ·· S. Hypot. AC : : S. Angle BAC ·· S. Leg BC.
S. 90d. ·· S. 54d. 25m. : : S. 29d. 30m. ·· S. 23d. 36m.

Note; the given Angle $\left\{\begin{matrix}\text{Acute}\\ \text{Obtuſe}\end{matrix}\right\}$ the required.
Leg is $\left\{\begin{matrix}\text{leſs}\\ \text{more}\end{matrix}\right\}$ than a Quadrant.

2. For the Leg AB, adjacent to the given Angle, the Proportion is this;

As the Tangent Complement of the Hypotenuſe, is to Radius; ſo is the Sine Complement of the given Angle to the Tangent of its adjacent Leg: Or,

As Radius, is to the Sine Complement of the given Angle; o is the Tangent of the Hypotenuſe, to the Tangent of the Leg equired: That is,

Radius ·· S. c. BAC : : T. Hypot. AC ·· T. Leg AB.
S. 90d. ·· S. 60d. 30m. : : T. 54d. 25m. ·· T. 50d. 34m.

Note; When each given thing is leſs, or more than 90d. the equired Leg is leſs than a Quadrant; but if one is leſs, and the ther more, the required Leg is more than a Quadrant.

3. For the Angle ACB, the Proportion is this;

As the Tangent Complement of the given Angle, is to Radius; o is the Sine Complement of the Hypotenuſe, to the Tangent Complement of the other Angle: Or thus,

As Radius is to the Sine Complement of the Hypotenuſe; ſo s the Tangent of the given Angle, to the Tangent Complement f the Angle required: This is,

Radius ·· S. c. Hypot. AC : : T. Angle BAC ·· T. c. Angle ACB
. 90d. ·· S. 35d. 35m. : : T. 29d. 30m. ·· T. 18d. 30m.
which ſubtract from 90d. reſts 71d. 47m. for the Angle ACB.

Note; When each given Thing is leſs, or more than 90d. he required Angle is Acute; but when one is more, and the ther leſs, 'tis Obtuſe.

Problem 3. Caſes 7, 8, 9. *A Leg and its adjacent Angle given*;

To find $\left\{\begin{matrix}1.\\ 2.\\ 3.\end{matrix}\right\}$ The $\left\{\begin{matrix}\text{Leg}\\ \text{Angle}\\ \text{Hypotenuſe}\end{matrix}\right\}$ oppoſite to the given $\left\{\begin{matrix}\text{Angle}\\ \text{Leg.}\end{matrix}\right.$

Example. *Plate* 4. *Fig.* 3.

In the Rectangle Triangle ABC, Right-angled at B, there is
iven $\left\{\begin{matrix}\text{Leg——AB 50d. 30m.}\\ \text{Angle BAC 29d. 30m.}\end{matrix}\right\}$ Leg BC, Angle ACB. and Hypot. AC required?

This Triangle is made by *Problem* 12, of *Spheric Trigonome* *Geometric*, in *pages* 125 and 126.

1. For the Leg BC oppoſite to the given Angle, the Proportion

As the Tangent Complement of the given Angle, is to the R dius; ſo is the Sine of its adjacent Leg, to the Tangent of its o poſite Leg required: Or thus;

As the Radius, is to the Sine of the given Leg; ſo is the Ta gent of its adjacent Angle, to the Tangent of its oppoſite Le That is,

Radius .. S. Leg AB : : T. Angle BAC .. T. Leg BC.
S. 90d. .. S. 50d. 30m. : : T. 29d. 30m. .. T. 23d. 35m.

Note; The given Angle Acute, the required Leg is leſs th a Quadrant, but when Obtuſe, then more than a Quadrant.

2. For the Angle ACB, oppoſite to the given Leg, the Propo tion is;

As Radius, is to the Sine Complement of the given Leg; ſo the Sine of its adjacent Angle, to the Sine Complement of its o poſite Angle required. That is,

Radius .. S. c. Leg AB : : S. Angle BAC .. S. c. Angle ACB.
S. 90d. .. S. 39d. 30m. : : S. 29d. 30m. .. S. 18d. 15m.
whoſe Complement 71d. 45m. is the Angle ACB.

Note; The given Leg leſs, or more than 90d. the Angle quired is Acute, or Obtuſe accordingly.

3. For the Hypotenuſe, the Proportion is;

As the Tangent of the given Leg, is to the Radius; ſo is t Sine Complement of its adjacent Angle, to the Tangent Compl ment of the required Hypotenuſe: Or thus,

As the Radius, is to the Sine Complement of the given Angl ſo is the Tangent Complement of it's adjacent Leg, to the Ta gent Complement of the Hypotenuſe: That is,

Radius .. S.c. Angle BAC : : T. c. Leg AB .. T. c. Hyp. AC.
S. 90d. .. S. 60d. 30m. : : T. 39d. 30m. .. T. 35d. 40m.
whoſe Complement 54d. 20m. is the Hypotenuſe AC.

Note; When each Thing is leſs, or more than 90d. the H potenuſe is leſs than a Quadrant; but if one is leſs, and the oth more, then the Hypotenuſe is more than a Quadrant.

Prob. 4. Caſe 10, 11, 12. *A Leg, and its oppoſite Angle give*

To ſind { 1. Leg } adjacent to the given { Angle.
2. Angle } { Leg.
3. Hypotenuſe.

Exampl

Example. *Plate* 4. *Fig.* 4.

In the Rectangular Spheric Triangle ABC, there is,

iven { Leg——BC 23d. 29m. { Leg AB, Angle ACB, and
Angle BAC 29d. 30m. } Hypotenuſe AC required.

This Triangle is made by Problem 13, of Spheric Trigono-
netry Geometric, in page 126.

1. For the Leg AB, adjacent to the given Angle, the Propor-
ion is this;

As Radius, is to the Tangent of the given Leg; ſo is the Tan-
ent Complement of its oppoſite Angle, to the Sine of the other
eg required: That is,

Radius .. T. Leg BC : : T. c. Angle BAC .. S. Leg AB.

T. 45d. .. T. 23d. 29m. : : T. 60d. 30m. .. S. 50d. 10m.

Note; If the unknown Angle be Acute, or Obtuſe, the re-
uired Leg accordingly is leſs, or more than a Quadrant.

Or, The Hypotenuſe and given Leg, each leſs, or more than
0d. the required Leg is leſs than a Quadrant; but if one is more,
nd the other leſs, 'tis more than a Quadrant.

2. For the Angle ACB adjacent to the given Leg, the Propor-
on is this;

As the Sine Complement of the given Leg, is to the Radius;
o is the Sine Complement of its oppoſite Angle, to the Sine of
s adjacent Angle: That is,

S. c. Leg BC .. Radius : : S. c. Angle BAC .. S. Angle ACB.

S. 66d. 31m. .. S. 90d : : S. 60d. 30m. .. S. 71d. 37m.

Note; If the Hypotenuſe and given Angle be each leſs, or
ore than 90d. the Angle required is Acute, but when one is
ore, and the other leſs, 'tis Obtuſe.

Or, the Leg adjacent to the given Angle being leſs, or more
an 90d. accordingly the Angle required is Acute or Obtuſe.

3. For the Hypotenuſe AC, the Proportion is this:

As the Sine of the given Angle, is to the Radius; ſo is the
ine of its oppoſite Leg, to the Sine of the Hypotenuſe required:
hat is,

S. Angle BAC .. Radius : : S. Leg BC .. S. Hypotenuſe AC.

S. 29d. 30m. .. S. 90d. : : S. 23d. 29m. .. S. 54d. 01m.

Note; If both Legs, or both Angles are of one Kind, the
ypotenuſe is leſs than a Quadrant, but if they be of different
inds, the Hypotenuſe is more than a Quadrant.

roblem 5. Caſe 13 and 14. *Both the Legs given; to find 1. Either of the Angles? 2. The Hypotenuſe?*

Example. *Plate* 4. *Fig.* 5.

In the Rectangular Spheric Triangle ABC, there is given, Leg { AB 50d. 30m. / BC 23d. 29m. } Angle BAC, or ACB, an / Hypotenuſe AC required.

This Triangle is made by Prob. 14. of Spheric Trigonometr Geometric, in page 125.

1. For either of the Angles, the Proportion is,

As the Tangent of one Leg, is to Radius; ſo is the Sine of th other Leg, to the Tangent Complement of the Angle oppoſite the firſt Leg: Or thus,

As Radius, is to the Sine of one Leg; ſo is the Tangent Com plement of the other Leg, to the Tangent Complement of th Angle oppoſite to the laſt Leg: That is;

Radius ·· S. Leg AB : : T. c. Leg BC ·· T.c. Angle BAC.

S. 90d. ·· S.50d. 30m. : : T. 66d. 31m. ·· T. 60d. 37m. who Complement 29d. 23m. is the Angle BAC: Alſo it is,

Radius ·· S. Leg BC : : T.c. Leg AB ·· T.c. Angle ACB.

S. 90d. ·· S.23d. 29m. : : T. 39d. 30m. ·· T. 18d. 11m. who Complement 71d. 49m. is the Angle ACB.

Note; If the Leg oppoſite to the required Angle be leſs than Quadrant, the Angle ſought is Acute; but if greater, then 't Obtuſe.

2. For the Hypotenuſe, the Proportion is thus;

As Radius, is to the Sine Complement of one Leg; ſo is th Sine Complement of the other Leg, to the Sine Complement the Hypotenuſe: That is,

Radius ·· S.c. Leg AB : : S.c. Leg BC ·· S. c. Hypot. AC.

S. 90d. S. 39d. 30m. : : S.66d. 31m. ·· S. 35d. 41m. who Complement 54d. 19m. is the Hypotenuſe AC.

Note, If both Legs be of one Kind, the Hypotenuſe is le than a Quadrant; but when of different Kinds (that is one Le more, the other leſs than a Quadrant) then the Hypotenu is more than a Quadrant.

Problem 6. Caſes 15 *and* 16. *Both the Oblique Angles given*

To find, 1. *Either of the Legs?* 2. *The Hypotenuſe?*

Example. *Plate* 4. *Fig.* 6.

In the Rectangular Spheric Triangle ABC, is given,

Angle { BAC 29d. 30m. / ACB 71d. 56m. } Leg AB, or BC, and / Hypotenuſe AC required?

This Triangle is made by Problem 15, of Spheric Trigono try Geometric, in page 128.

1. For either of the Legs, the Proportion is thus;

s the Sine of one Angle, is to Radius; ſo the Sine Comple-
nt of the other Angle, to the Sine Complement of its oppoſite
g: That is,
S. Angle BAC ·· Radius : : S.c. Angle ACB ·· S.c. Leg AB
S. 29d. 30m. ·· S. 90d. : : S. 18d. 04m. ·· S. 39d. 02m.
oſe Complement 50d. 58m. is the Leg AB: Alſo it is,
Angle ACB ·· Radius : : S. c. Angle BAC ·· S. c. Leg BC.
71d. 56m. ·· S. 90d. : : S. 60d. 30m. ·· S. 66d. 17m.
oſe Complement 23d. 43m. is the Leg BC.

Note; If the Angle oppoſite to the required Leg be Acute, the
g ſought is leſs than a Quadrant; but if Obtuſe, then 'tis
ater than a Quadrant.

2. For the Hypotenuſe, the Proportion is thus;

As Radius, is to the Tangent Complement of one Angle: ſo
the Tangent Complement of the other Angle, to the Sine
mplement of the Hypotenuſe: That is,
dius ·· T.c. Angle BAC : : T.c. Angle ACB ·· S.c. Hyp. AC.
.45d. ·· T. 60d. 30m. : : T. 18d. 04m. ·· S. 35d. 13m.
hoſe Complement 54d. 47m. is the Hypotenuſe AC.

Note; The Angles of one Kind, the Hypotenuſe is leſs than a
uadrant; but when of different Kinds, 'tis more than a Qua-
ant.

ction V. *Four Axioms, by which the 12 Caſes of Oblique-angled Spheric Triangles are ſolved.*

xiom 1. IN all Spheric Triangles, the Sines of their Sides are in direct Proportion to the Sines of their oppoſite
ngles: That is,

1. As the Sine of a Side, is to the Sine of its oppoſite Angle;
is the Sine of any other Side, to the Sine of its oppoſite Angle;

2. As the Sine of an Angle, is to the Sine of its oppoſite Side;
is the Sine of any other Angle, to the Sine of its oppoſite Side.

Axiom 2. *Firſt*, As the Sine of half the Sum of two Sides,
ontaining an Angle) is to the Sine of half their Difference;
So is the Tangent Complement of half the contained Angle, to
e Tangent of half the Difference of the other two Angles.

Again,

Secondly, As the Sine Complement of half the Sum of two Sides
ontaining an Angle) is to the Sine Complement of Half their
ifference;
So is the Tangent Complement of half the contain'd Angle,
the Tangent of half the Sum of the other two Angles.

Axiom 3. *Firſt*, As the Sine of half the Sum of two Angles,
to the Sine of half their Difference;

So is the Tangent of half their interjacent Side, to the Tangent of half the Difference of the other two Sides: Again,

Secondly, As the Sine Complement of half the Sum of two Angles, is to the Sine Complement of half their Difference;

So is the Tangent of half their interjacent Side, to the Tangent of half the Sum of the other two Sides.

Axiom 4. As the Rectangle of the Sines of the two containing Sides, is to the Square of the Radius;

So is the Rectangle of the Sines of half the Sum of the three Sides, and of the Difference of the Side oppoſite thereunto, to the Square of the Sine Complement of half the contained Angle ſought.

The Explanation and Uſe of theſe four Axioms, you will find in the Solution of the following *Caſes* of Oblique Spheric Triangles.

Problem 7. Caſe 1, 2 *and* 3.

Two Sides, and an oppoſite Angle given; to find

1. The Angle oppoſite to the other Side,
2. The Angle contained between them,
3. The third Side ——————

if the required oppoſite Angle be foreknown to be Acute, or Obtuſe.

Example. *Plate* 4. *Fig*. 7.

In the Oblique Spheric Triangle ACD, there is

given	Side	AC 34d. 07m.	Angle ACD being Obtuſe	req.
	Side	AD 65d. 20m.	Angle CAD ——————	
	Angle	ADC 27d. 30m.	Side CD ——————	

This Triangle is made by Prob. 16, of *Spheric Trigonometry Geometric*, in pages 128 and 129.

1. For the oppoſite Angle ACD, the Proportion (by *Axiom* 1.) is thus;

As the Sine of the Side AC, is to the Sine of the Angle ADC; So is the Sine of the Side AD, to the Sine of the Angle ACD; That is,

S. Side AC .. S. Angle ADC : : S. Side AD .. S. Angle ACD.

S.34d.07m. .. S. 27d. 30m. : : S.65d.20m. .. S. 48d. 25m.

Which ſubtract from 180d. reſteth 131d. 35m. for the Angle ACD, it being required to be Obtuſe.

2. For the contained Angle CAD (having before found the oppoſite Angle) the Proportion (by *Axiom* 2. *Part* 1. inverted,) is thus;

As the Sine of half the Difference of the Sides AD and AC, is to the Sine of half their Sum; ſo is the Tangent of half the Difference of the Angles ACD, and ADC, to the Tangent Complement of half the Angle CAD; and,

;. For the third Side CD, (having found the oppoſite Angle) Proportion, (by *Axiom* 3. *Part* 1. inverted) is thus;
\s the Sine of half the Difference of the Angles ACD, and)C, is to the Sine of half their Sum;
So is the Tangent of half the Difference of the Sides AD and ;, to the Tangent of half the Side CD: That is,

d. m. | d. m.
eAD 65.20 | Ang. ACD 131.35
e AC 34.07 d. m. | Ang. ADC 27.30 d. m.
n is 99.27 } ½ { Sum 49.43 | Sum is 159.05 } ½ { Sum 79.32
fer. 31.13 } ½ { Diff. 15.36 | Diff. is 104.05 } ½ { Diff. 52.02

Diff. Sides .. S. ½ their Sum : : T. ½ Diff. Ang. .. T. c. ½ CAD
15d. 36m. .. S. 49d. 43m. : : T. 52d. 02m. .. T. 74d. 37m.
Which ſubtract from ——— —— —— ——— 90d. 00m.
Remainder is half the Angle CAD ——— —— 15d. 23m.
Which being doubled ——— —— —— ——— 15d. 23m.
Produceth the required Angle CAD ——— —— 30d. 46m.
Diff. Ang... S. ½ their Sum : : T. ½ Diff. Sides .. T. ½ CD.
52d. 02m. .. S. 79d. 32m. : : T. 15d. 36m... T. 19d. 12m.
Which being doubled ——— ——— ——— 19d. 12m.
Produceth the required Side CD ——— ——— 38d. 24m.

Problem 8. Caſe 4, 5 and 6.

Two Angles, and one Side oppoſite given; to find,

1. The Side oppoſite to the other Angle, }
2. The interjacent, or Side between them } if the required
3. The Third Angle ——— ——— —— }

›oſite Side be foreknown to be more, or leſs than a Quadrant.

Example. *Plate* 4. *Fig.* 8.

In the Oblique Spheric Triangle ACD, *there is given.*

gle CAD 30d. 48m. { Side AC leſs than 90d. }
gle ADC 27d. 30m. { Side AD —— ——— } required?
e CD 38d. 28m. { Angle ACD ——— —— }

This Triangle is made by *Problem* 17. of *Spheric Trigonometry* *›metric*, in *page* 129.

1. For the oppoſite Side AC, the Proportion by *Ax.* 1. is thus;
As the Sine of the Angle CAD, is to the Sine of the Side CD;
is the Sine of the Angle ADC, to the Sine of the Side AC.
at is,

Angle CAD .. S. Side CD : : S. Angle ADC .. S. Side AC req.
30d. 48m. .. S. 38d. 28m. : : S. 27d. 30m. .. S. 34d. 07m.

2. For the interjacent Side AD, (having firſt found the oppo- Side) the Proportion (by *Axiom* 3. *Part* 1. inverted) is thus;

As the Sine of half the Difference of the Angles CAD an ADC, is to the Sine of half their Sum;

So is the Tangent of half the Difference of the Sides CD an AC, to the Tangent of half the Side AD: And,

3. For the third angle ACD, (having firſt found the oppoſit Side) the Proportion, (by *Axiom* 2. *Part* 1. inverted) is thus;

As the Sine of half the Difference of the Sides CD and AC, i to the Sine of half their Sum;

So is the Tangent of half the Difference of the Angles CA and ADC, to the Tangent Complement of half the Angl ACD: That is,

d. m. d. m.
Ang. $\left\{\begin{array}{l}\text{CAD 30 48}\\ \text{ADC 27 30}\end{array}\right.$ Side $\left\{\begin{array}{l}\text{CD 38 28}\\ \text{AD 34 07}\end{array}\right.$ d. m
Sum is 58 18 $\left.\begin{array}{l}\\ \\ \end{array}\right\}\frac{1}{2}\left\{\begin{array}{l}\text{Sum 29.09}\\ \text{Diff. 01.39}\end{array}\right.$ | Sum is 72 35 $\left.\begin{array}{l}\\ \\ \end{array}\right\}\frac{1}{2}\left\{\begin{array}{l}\text{Sum 36 1}\\ \text{Diff. 02 1}\end{array}\right.$
Difference 03 18 | Diff. is 04 21
S. half Diff. Angl. ·· S. half their Sum : : T. ½ Diff. Sides ·· T. ½ A
S. 01d. 39m ·· S. 29d. 09m. : : T. 02d. 10m. ·· T. 32d. 37m
Which being doubled ——————— 32d. 37m
Produceth the Interjacent Side AD ——————— 65d. 14m
S. ½ Diff. Sides ·· S. ½ their Sum : : T. ½ Diff. Angles ·· T.c. ½ AC
S. 02d. 10m. ·· S. 36d. 17m. : : T. 01d. 39m. ·· T. 24d. 16m
Which ſubtract from ——————— 90d. 00m
Remainder is half the Angle ACD ——————— 65d. 44m
Which being doubled ——————— 65d. 44m
Produceth the Angle ACD to be ——————— 131d. 28m

Note; In the ſix preceeding Caſes, the three given Term without the Quality of a Fourth, are not ſufficient, whereby on ſingle Anſwer may be found; and the Quality of the Fourth i not always diſcoverable by the given Terms; Therefore they ar called the *Six doubtful Caſes*.

Problem 9. Caſe 7, and 8.

Two Sides, and one Angle between them given; *to find*

1. *Either of the other Angles*;
2. *The third Side, or Side oppoſite to the given Angle.*

Example. *Plate* 4. *Fig.* 9.

In the Oblique Spheric Triangle ACD, *there is*

given $\left\{\begin{array}{l}\text{Side AC 34d. 06m.}\\ \text{Side AD 65d. 20m.}\\ \text{Angle CAD 30d. 46m.}\end{array}\right\}$ $\begin{array}{l}\text{Angle ACD, or}\\ \text{Angle ADC, and}\\ \text{Side CD is —}\end{array}\Big\}$ required

Th

This Triangle is made by *Problem* 18. of *Spheric Trigonometry metric*, in pages 129 and 130.

'or the Angle ACD, or ADC, the Proportion (by *Axiom* 2. *ts* 1 and 2) is thus;

d. m. | d. m. | d. m.
e { AD 65.20 | Angle CAD 30.46
{ AC 34.06 | The Half is 15.23 } ——— { 74.37
n of Sides 99.26 } The $\frac{1}{2}$ { Sum 49.43 } its Comp. { 40.17
fer. Sides 31.14 } { Diff. 15.37 } ——— { 74.23

S. $\frac{1}{2}$ Sum AD & AC .. S. $\frac{1}{2}$ Diff. : : T. c. $\frac{1}{2}$ CAD .. T. $\frac{1}{2}$ Diff. Ang.
S. 49d. 43m. .. S. 15d. 37m. : : T. 74d. 37m. .. T. 52d. 03m.

Then again,

.c. $\frac{1}{2}$ Sum Sides .. S. c. $\frac{1}{2}$ Diff. : : T. c. $\frac{1}{2}$ CAD .. T. $\frac{1}{2}$ Sum Angles
S. 40d. 17m. .. S. 74d. 23m. : : T. 74d. 37m. .. T. 79d. 32m.
it add the Half Difference found above ——— 52d. 03m.
The Sum is the greater Angle ACD ——— 131d. 35m.
And being ſubtracted, is the leſs Angle ADC ——— 27d. 29m.

Note; If the Sum of the two containing Sides exceeds a Semile, then ſubtract each Side from 180 Degrees, and proceed h thoſe Remainders as with the Sides given; the Proportion duces the Supplement of the Angle required to a Semicircle.

'or the third Side CD, or Side oppoſite to the given Angle, Proportion (after the Work above is done) may be made by *iom* 1. Or it may be deduced from the Lord *Napier's Catholic* poſition (by a ſuppoſed Perpendicular, let fall from one End of leſs given Side, to the greater Side given, reducing the Oblique iangle into two Rectangulars) which finds the Side oppoſite to given Angles at two Proportions, without finding the Angles; d it's thus,

1. As Radius is to the Sine Complement of the contained An-; So is the Tangent of the leſs given Side, to the Tangent of 'ourth Arc.

Then, if the contained Angle be Acute, ſubtract the Fourth c from the greater given Side, but when it is Obtuſe from the pplement thereof to a Semicircle, or 180 Degrees, the Reinder is called the *Reſidual Arc*; Then,

2. As the Sine Complement of the Fourth Arc, is to the Sine mplement of the *Reſidual Arc*;

So is the Sine Complement of the leſs given Side, to the S
Complement of the Sine required; That is,
As Radius .. S.c.AngleCAD : : T. Side AC .. T. Fourth Ar
As S. 90d. .. S. 59d. 14m. : : S. 34d. 06m. .. T. 30d. 11m
which being ſubtracted from the Side AD ——— 65d. 20m
The Remainder is the Reſidual Arc ——— 35d. 09m
Then,
As S. c. 4th Arc .. S.c.Reſid.Arc : : S.c.SideAC .. S. c. Side C
As S. 59d. 49m. .. S. 54d. 51m. : : 55d. 54m. .. S. 51d. 34
whoſe Complement 38d. 26m. is the Side CD required.

Note; When the contained Angle, and Reſidual Arc, are e
more, or leſs than 90 Degrees, the Side ſought is leſs than a Q
drant; but when one is more, and the other leſs, 'tis more tha
Quadrant.

Problem 10. Caſe 9 *and* 10.

Two Angles and one Side between them given;

To find { 1. *Either of the other Sides?*
2. *The Angle oppoſite to the given Side?*

Example. In the *Oblique Spheric Triangle* ACD, there is giv

The	Angle ACD	131d. 34m.	Side	AC, or	required
	Angle ADC	27d. 30m.	Side	AD, and	
	Side CD	21d. 28m.	Angle	CAD is	

This Triangle is made by *Problem* 19. of *Spheric Trigonom*
Geometric, in page 130. See *Plate* 4. *Fig*. 10.

For the Side AC or AD, the Proportion (by *Ax*. 3. *Part*
and 2.) is thus;

	d. m.		d. m.
Angle ACD	131.34.	The Side CD	38.28.
Angle ADC	27.30.	The Half is	19.14.

						d.
Sum of Angles	159.04.	The ½	Sum	79.32.	its Com.	10
Difference is	104.04.		Diff.	52.02.		37

As S. ½ Sum Ang. .. S. ½ their Diff. : : T. ½ SideCD .. T. ½ Dif. Si
As S. 79d. 32m. .. S. 52d. 02m. : : T. 19d. 14m. .. T. 15d. 38
Then again,
As S.c. ½ SumAn. .. S.c. ½ theirDiff. : : T. ½ SideCD .. T. ½ SumSi
As S. 10d. 28m. .. S. 37d. 58m. : : T. 19d. 14m. .. T. 49d. 45
To it add the half Difference found above ——— 15d. 38
The Sum is the greater Side AD ——— ——— 65d. 23
And being ſubtracted, is the leſs Side AC ——— 34d. 07

Note; If the Sum of the two given Angles exceed 180 I
grees, then ſubtract each given Angle from 180 Degrees, a
proceed with thoſe Remainders as with the Angles given;
Operation will produce each required Side's Supplement to a Se
circle, or 180 Degrees.

For the Angle CAD, the Angle oppoſite to the given Side, the roportion (after the Work above is done) may be by *Axiom* 1. Or om the *Catholic Propoſition* (by a Perpendicular ſuppoſed to be let ll from the greater given Angle to its oppoſite Side) thus ;

As Radius, is to the Sine Complement of the interjacent Side ; is the Tangent of the leſs given Angle, to the Tangent of a ourth Arc.

Then, if the interjacent Side be more than a Quadrant, ſub-act the Fourth Arc from the greater given Angle ; but when 'tis ſs, from the Supplement thereof to 180 Degrees, the Remain-r is the Reſidual Arc ; Then,

2. As the Sine Complement of the Fourth Arc, is to the Sine omplement of the Reſidual Arc ;

So is the Sine Complement of the leſs given Angle, to the Sine omplement of the Angle required. That is,

As Radius .. S. c. Side CD : : T. Angle ADC .. T. 4th Arc.
As S. 90d. .. S. 51d. 32m. : : T. 27d. 30m. .. T. 22d. 11m.
ich ſubtract from (Suppl. of the Angle ACD) 48d. 26m.
The Remainder is the Reſidual Arc —— —— 26d. 15m.

Then,

c. 4th Arc. .. S.c.Reſid.Arc : : S.c.An.ADC .. S.c.An.CADreq.
67d. 49m. .. S. 63d. 45m. : : S. 62d. 30m. .. S. 59d. 13m.
ioſe Complement 30d. 47m. is the Angle CAD required.

Note ; When the adjacent Side and Reſidual Arc are each more leſs than 90d. the Angle ſought is Acute ; but when one is re, and the other leſs, 'tis Obtuſe.

oblem 11. Caſe 11. *Three Sides given, to find any of the Angles ;*

Example. *Plate* 4. *Fig.* 11.

In the Oblique Spheric Triangle ACD there is given ;

	AD 65d. 20m.		ACD, or
The Side	CD 38d. 26m.	Angle	ADC, or
	AC 34d. 08m.		CAD required ?

This Triangle is made by Problem 20, of Spheric Trigono-try Geometric, in pages 130 and 131.

The Reſolution of this, and the following Caſe depends upon 4th *Axiom* ; and for the greater Diſpatch, obſerve theſe fol-ving Directions, *viz.*

1. Add the three Sides together, and from their half Sum ſub-ct the Side oppoſite to the Angle required, noting the Re-inder.

2. To the Complement Arithmetic of the Logarithmic Sines o the containing Sides, add the Logarithmic Sines of the half Sum and the Remainder; Half the Total of theſe four Logarithms, is the Logarithmic Sine of Half the required Angle's Supplement to 180 Degrees.

The Operation for the Angle ACD, is thus;

		d.	m.		
Side	CD	38	26	The containing Sides	S. co. ar. 0.20648
	AC	34	08		S. co. ar. 0.250944
	AD	65	20	½ Sum Sides 68d. 57m. S. ——	9.97000
Sum is —		137	54	Remainder is 3d. 37m. S. ——	8.79989
Half Sum is		68	57	Sum of the four Logarithms is	19.22733
Remain —		3	37	24d. 15m. S. ½ Sum.	9.61366

Double it ———— 24d. 15m.
The Sum is ——— 48d. 30m.
Which ſubtract from 180d. 00m.
Remainder is the Angle ACD 131d. 30m.

In like Manner you may find any other Angle by Logarithms.

Or thus,

By Gunter's Scale, *ſay*,

1. As Radius, is to the Sine of one of the containing Sides; So is the Sine of the other containing Side, to a Fourth Sine: Then,

2. As that 4th Sine, is to the Sine of the half Sum of th three Sides; ſo is the Sine of the Remainder to a fifth Sine againſt which on the Line of verſed Sines is the Angle required.

That is,

As Radius .. S. Side CD : : S. Side AC .. a Fourth Sine.
As S. 90d. .. S. 38d. 26m. : : S. 34d. 08m. .. S. 20d. 25m. The
As Fourth Sine .. S. ½ Sum Sides : : S. Remainder .. a Fifth Sine
As S. 20d. 25m. .. S. 68d. 57m. : : S. 03d. 37m. .. S. 9d. 43m.
againſt which on the Line of Verſed Sines, is 131d. 30m. th
Angle ACD as before.

Problem 12. Caſe 12. *The Angles given; to find a Side.*

Example. *Plate* 4. *Fig.* 12.

In the Oblique Spheric Triangle ACD; there is given,

The Angle { ACD 30d. 47m. / ADC 27d. 30m. / CAD 131d. 34m. } : The Side { CD, or / AC, or / AD, required?

This Triangle is made by *Problem* 21. of *Spheric Trigonomet Geometric*, in Page 131.

Th

This *Caſe* is likewiſe perform'd by the Directions in *Caſe* 11, ıe Angles being accounted Sides, and the Sides Angles; and ıen taking the Supplement of the greater (given) Angle to 80 Degrees.

For the Side A D, the Operation is thus;

d. m.
up. Ang. CAD 48 26 } The adjacent Angles { S. co. ar. 0.125992
'ngle { ADC 27 30 } S. co. ar. 0.335594
ACD 30 47 | $\frac{1}{2}$ Sum Ang. 53d. 21m. S. —— 9.904335
um is —— 106 43 | Remainder 22d. 34m. S. —— 9.584058
[alf Sum is — 53 21 | Sum of the four Logarithms is 19.949979
.emainder — 22 34 | ———— 70.44 S. half Sum 9.974989
Double it ———— 70.44
The Sum is ———— 141.28 Which
Subtract from ———— 180.00
Remainder is the Side AD 38.32

In like manner may any other Side be found by Logarithms,)r thus,

By Gunter's *Scale.*

1. As Radius, to the Sine of one of the adjacent Angles (to ıe Side required) ſo is the Sine of the other adjacent Angle, ɔ a Fourth Sine.

2. Then, as the Fourth Sine, is to the Sine of the half Sum f the three Angles; ſo is the Sine of the Remainder, to a fifth ine; againſt which, on the Line of Verſed Sines, is the Side equired.

That is,

\s Radius ·· S. Sup. CAD : : S. Angle ADC ·· a Fourth Sine.
\s S. 90d. ·· S. 48d. 26m. : : S. 27d. 30m. ·· S. 20d. 13m.

Then again,

\s Fourth Sine ·· S. $\frac{1}{2}$ Sum Angles : : S. Remainder ·· a Fifth Sine.
\s S. 20d. 13m. ·· S. 53d. 21m. : : S. 22d. 34m. ·· S. 63d. 00m.
\gainſt which, on the Line of Verſed Sines, is — 38d. 32m.
he Side A D, as above.

Note; When the greateſt Side (C D, which ever is oppoſite o the greateſt Angle) is required, the Operation will produce he Supplement thereof to a Semi-circle; wherefore, if it be ubtracted from 180d. it leaves the Side ſought: Or (by the *Loga-*

Logarithms) if you omit this Part of the Operation, (*viz.* the *Subtraction from* 180 *Degrees*) you have the Side required.

So much for the Doctrine of *Spheric Triangles*; the Application follows.

CHAPTER VI.

Containing the Deſcription and Uſe of the Globes.

HAving finiſhed *Spheric Trigonometry*, it remains to ſhew its Uſes in *Geography*, *Great Circle Sailing*, and *Aſtronomy*. In order to the perfect Underſtanding of theſe, it is requiſite firſt to be acquainted with the Nature and Uſe of the Globes, which I will endeavour to perform with Brevity, and as clearly as poſſible.

Section I. *The Deſcription and Uſe of Globes in General.*

Definition 1. A *Globe* (as to its Name and Figure) is ſo generally known, that 'tis needleſs here to produce a Mathematical Definition of it; but as to the Kinds of Material Globes, and their Parts, it's neceſſary ſomething ſhould be ſaid.

2. The Kinds of Globes are two; *Terreſtrial* and *Cœleſtial*, which together with their Appurtenances, are for the lively Repreſentation of the Natural Situation, and Poſition of the Earth and Heavens, and are uſeful for the demonſtrating (by Repreſentation and Reſolution of) any Problem belonging to the Sphere of Heaven, or Earth, either in *Geography*, *Navigation*, or *Aſtronomy*.

3. The Appurtenances appertaining to Material Globes are Six; the Body or Globe itſelf, Brazen Meridian, Quadrant of Altitude and its Screw, Hour-Circle and Index, Wooden Frame or Horizon, and Braſs Semi-Circle of Poſition; all may be uſed with either Globe; yet the laſt being of leaſt Uſe, may be ſupplied by the Quadrant of Altitude.

4. The *Body*, or *Globe* itſelf, is an Emblem of Heaven, or of Earth; on which are drawn diverſe Lines and Circles, uſeful and proper for the Explication thereof.

5. The *Brazen Meridian*, is the Ring in which the Globe hangeth, and turneth upon its Axis, being two Wires iſſuing from its Body; and is divided into four Quadrants, each 90 Degrees, and figured 10, 20, 30, &c. to 90.

Plate 4. Fig. I.

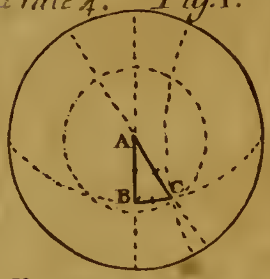


Fig. II.

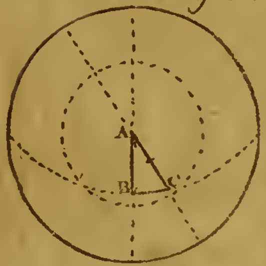


Fig. III.

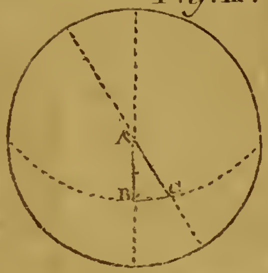


Fig. IV.

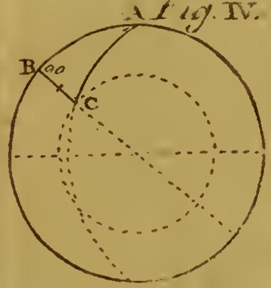


Fig.

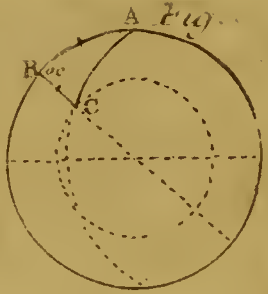


Plate 4. Fig. I.

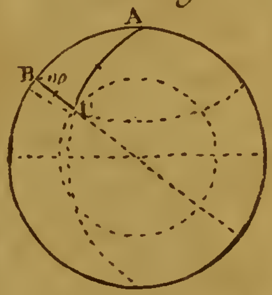


Fig. II.

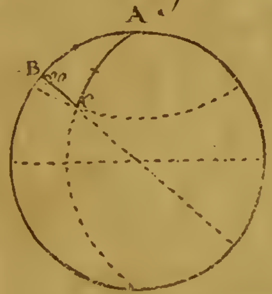


Fig. III.

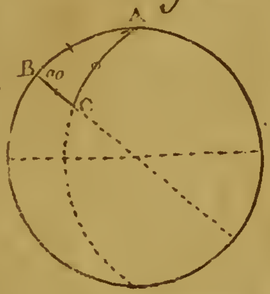


Fig. VI.

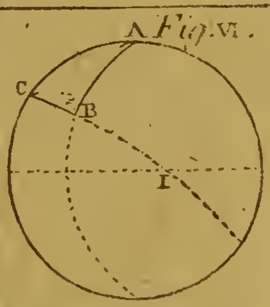


Fig. VII.

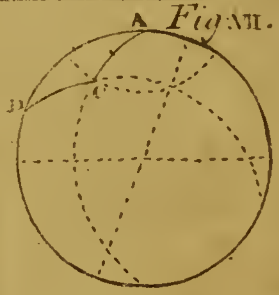


Fig. VIII.

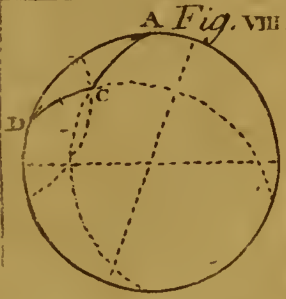


Fig. IX.

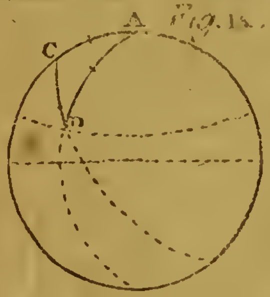


Fig. X.

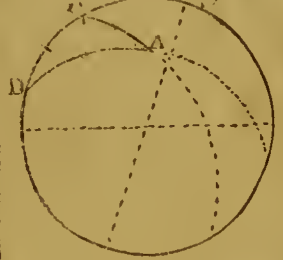


Fig. XI.

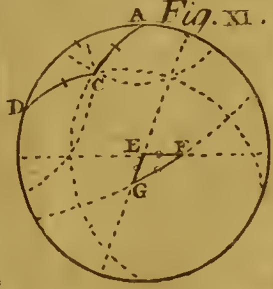
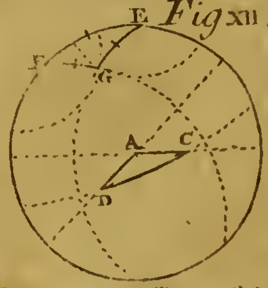


Fig. XII.



Place next to Page 150

6. The *Quadrant of Altitude*, is a narrow thin Slip of Braſs ith a Notch, Nut, and Screw at one End ; 'tis divided into 90d. hich by Rotation deſcribe the Almicanters, or Circles of Altiude, and the Edge repreſents an Azimuth Circle.

7. The *Hour Circle* is a flat Ring of Braſs, ſo contrived, that may be took off, and fixed about either Pole of the Globe ; 'tis ivided into 24 Hours of a Natural Day ; each Hour is divided ino Halves and Quarters, to this belongs an Index having a round ole at one End, to fix it on the Axis of the Globe.

8. The *Wooden Frame*, or *Horizon*, is circular and flat, in which e Brazen Meridian doth move through two Notches, diametrilly oppoſite, and alſo in a third Notch made in a Central Piece f Wood or Braſs at the Bottom of it; On the upper Part is a 'alendar, ſhewing the Day of the Month, Sun's Place in the cliptic, the Rumbs, or Points of the Compaſſes, *&c.*

9. The *Semi-circle of Poſition*, is a Semi-Circle of Braſs ; the pper Side is divided into 180 Degrees ; it ſerveth to meaſure Diances, either on the Terreſtrial or Cœleſtial Globe.

Section II. *The Deſcription and Uſe of the* Terreſtrial Globe.

THE *Terreſtrial Globe*, hath on the Superficies of its Body, the whole Form and Faſhion of the Earth and Sea, deſcribed ; ith the Circles of the Sphere, as Equator, Meridians, Trocs, *&c.*

In order to a clear underſtanding the Uſe of this Globe, obrve theſe following Geographic Definitions.

1. The *Earth*, together with the *Sea*, compoſeth that round ody called the *Orb*, or Globe of the Earth, which is circumribed by Lines Real, and Imaginary.

2. The *Real Lines*, are ſuch as agree with the Terreſtial Globe y Nature, and ſo divide it into Continents, Iſlands and Seas : The maginary Parts, are ſuch as are applied to it by Virtue of our Unerſtanding ; and not being materially ſuch, are ſuppoſed to be on e Earth : Theſe Imaginary Lines are either ſtrait or circular.

3. The *Axis*, is a ſtrait Line imagined to paſs through the enter of the Earth, the Extreme Points are the Poles on which e World is ſuppoſed to move ; one called the Artic, or North ole ; the other the Antartic, or South Pole ; 'tis repreſented by e Wires on which the Globe turneth.

4. The *Circular Lines*, are either greater, as the Meridian, orizon, Equator ; or leſs, as Tropics, Polar Circles, Parallels f Latitude.

5. *Meridian*, is a Circle paſſing through the Poles of the Earth the Zenith and Nadir; croſſeth the Equator at Right Angles, an divideth the Earth into two equal Parts; one Eaſt, the other Weſt It is ſo called, becauſe when the Sun cometh to the Meridian o any Place, 'tis then Noon, or Mid-day there; they are infinite i Number, for all Places from Eaſt to Weſt have their ſeveral Meridians.

Of theſe, one is called the Firſt, or Chief Meridian, fro which the Longitude of Places is reckon'd; 'tis of ſpecial Not and Uſe, but variouſly placed by Geographers; 'Tis frequently repreſented on the Globe by a double Line paſſing through the Poles and is divided into twice 90 Degrees, numbred from the Equato towards each Pole, ending in 90 Degrees.

6. The *Horizon*, is that Circle which comprehendeth all tha Space of the Earth which is viſible, and diſtinguiſheth it from tha (lying under the Horizon) which is inviſible, 'tis either Senſible o Rational.

The *Senſible Horizon*, is that apparent Circle, which extends itſelf quite round about us, dividing the Heavens and Earth into tw unequal Parts; and being limited by the Sight, is ſometime greater or leſs, according to the Situation of the Place.

The *Rational Horizon*, is a Circle dividing the Heavens and Earth into two equal Parts, whoſe Poles are the Zenith and Nadir: By this Circle our Days and Nights are meaſured, and the diverſe Riſings and Settings of the Sun, Moon, and Stars, do appear: 'Tis repreſented on the Globe by the upper Part of the Wooden Frame.

Note; The *Meridian* and *Horizon*, are moveable with the Mutation of Places.

7. The *Equator*, is a Circle under the Equinoctial in the Heavens, compaſſing the Earth in the Middle between its two Poles, dividing it into two equal Parts, called the Northern and Southern Hemiſpheres; from it, the Latitude of Places is reckon'd, either North or South; This Circle is repreſented on the Globe by a double, or treble Line, divided into 360 Degrees, and number'd 10, 20, 30, &c. from the Left-hand towards the Right, till it end in 360 Degrees, but in the modern Globes, graduated from the firſt Meridian, both Ways, 10, 20, 30, &c. until both Graduations meet in 180d. at the oppoſite Meridian.

This Circle is called *Equator*, becauſe when the Sun comes to it, which is twice a Year, (*viz.* about the 21ſt of *March*, at is Entrance into *Aries*; and again into *Libra*; about the 23d. of eptember) he makes equal Days and Nights, throughout the World; And upon it is writ in Capital Letters, *Linea ſub Æqui- octiali*, or *Linea Equinoctialis*.

8. The *Leſs Circles*, deſcribed on Globes, are called Parallel ircles, ſome of which have particular Names, as *Tropics*, and *olar Circles*.

9. The *Tropics* are two, being parallel to the Equator and di- ant from it 23d. 29m. That on the North Side of it, is called e *Tropic of Cancer*, at which the Sun hath its greateſt North eclination; then making to us (and all Places in North Latitude) e longeſt Day, and ſhorteſt Night; which is about the 21ſt of *une*; The other, on the South Side, is called the *Tropic of Ca- icorn*, at which the Sun hath his greateſt South Declination, aking then our ſhorteſt Day and longeſt Night, which is about e 22d of *December*; Theſe Tropics have their Names thus, *Tro- cus ſub Cancro*, and *Tropicus ſub Capricorno*.

10. The *Polar Circles* are two, being alſo parallel to the Equa- r, and compaſſing the Poles of the World, at 23d. 29m. Di- nce; That about the North Pole is called the *Artic-Circle*, and e other the *Antartic-Circle*, and are writ thus, *Circulus ſub Ar- o Polo*, and *Circulus ſub Antartico Polo*.

Theſe Tropics and Polar Circles, divide the Globe of the Earth o five Parts, called *Zones*, of which three were accounted by the cients to be ſo intemperate as to be uninhabitable, theſe *Zones* e called *Torrid*, *Frigid*, and *Temperate*; that is, one *Torrid* or *urning Zone*, two *Temperate*, and two *Frigid* or *Frozen Zones*.

11. The *Torrid Zone*, is all that Space of Earth and Sea, hich lieth between the Tropics of *Cancer* and *Capricorn*.

12. The two *Temperate Zones*, are contained between each ropic and a Polar Circle.

13. The two *Frigid Zones*, are contained between each Polar rcle and its Pole; that is, one within the Artic Circle; and other encompaſſed by the Antartic.

Thus much of the Imaginary Lines, and Parts of the Earth: he Real Parts, are Earth and Water, in general divided into ir Parts or Quarters, called *Europe*, *Aſia*, *Africa*, and *America*; ch of theſe, and conſequently the whole Globe, is divided into ntinents, Iſlands, and Seas.

14. A *Continent*, is a great Quantity of Land, not divided by Sea, wherein are ſeveral Empires, Kingdoms, and Countries

conjoin'd;

conjoined; as *Europe*, *Aſia*, and *Africa* is one Continent, a *America* is another.

15. An *Iſland*, is a Part of the Earth that is environed or e compaſſed round by the Sea; as *Great-Britain*, and alſo *Irelan* *&c.* are Iſlands.

In *Continents*, and *Iſlands*, are theſe Parts obſervable, *viz.* *Pe inſula*, *Iſthmus*, and *Promontory*.

16. *Peninſula*, is ſuch a Part of Land as is almoſt environ round with Water, and is joined to the Land by an Iſthmus, the *Morea* in the *Levant*.

17. An *Iſthmus*, is a narrow Neck of Land between two Se which joineth the Peninſula to the Continent, as *Corinth* *Greece*.

18. A *Promontory*, is a high Hill, Mountain, or Cape of La that ſhooteth itſelf into the Sea; as *Cape de Verde*, and the *Ca of Good Hope* in *Africa*.

19. A *Place*, in reſpect to the Heavens, is either Eaſt, We North, or South.

Theſe Places are ſaid to be Eaſt, which lie in the Eaſte Hemiſphere (terminated by the Firſt Meridian) or where the S riſeth.

And thoſe are Weſt, which lie Weſterly of the ſaid Meridia or towards the Setting of the Sun.

Thoſe Places are properly North, which lie betwixt the Equ tor and the Artic Pole.

And thoſe Places are South, which lie betwixt the Equat and the Antartic Pole;

But according to general Acceptation, Places are ſaid to North or South, according as they are ſituate to the Northward Southward of the Equator, even to each Pole.

The Antients have divided the Inhabitants of the Earth in *Periœci*, *Antiœci*, and *Antipodes*.

20. The *Periœci*, are ſuch who live under the ſame Paralle but in oppoſite Points of it; that is, they are in the ſame Lat tude, but their Difference of Longitude is 180 Degrees.

21. The *Antiœci*, are ſuch as have the ſame Meridian, a equally diſtant from the Equator, but the one North and t other South; that is, two Places in one Longitude, and each equal, but contrary Latitudes.

22. The *Antipodes*, are ſuch as inhabit two Places of the Eart which are diametrically oppoſite; that is, two Places whoſe Di ference of Latitude and Difference of Longitude are each 18 Degrees, and ſuch walk Feet to Feet.

Th

The *Earth*, being encompaſſed with Water, whoſe Waſhings
ſurrounding the dry Land, cut out and ſhape many winding
ys, Creeks, and meandring Inlets, giving Terminations to the
ur Regions of the Earth, and extending itſelf round them all,
out one continued Ocean. Wherefore,

The *Water*, is either Ocean, Seas, Straits, Creeks, Lakes, Ri-
s, Bays, *&c.*

23. The *Ocean*, is a general Collection, or Rendezvous of all
aters.

24. A *Sea*, is a Part of the Ocean, to which we muſt ſail
ough ſome Strait; as the *Mediterranean*, and *Baltic Sea*.

25. A *Strait*, is a narrow Part of the Ocean, lying betwixt
Shores, and opening a Way into ſome Sea; as the Straits of
raltar, that leads into the *Mediterranean Sea*; and the *Sound*,
ch leads into the *Baltic Sea*.

6. A *Creek*, is a ſmall narrow Part of the Sea, or River, that
th up but a little Way into the Land.

7. A *Bay*, is a great Inlet of the Land, as the Bay of *Biſcay*,
the Bay of *Mexico*; otherwiſe a Bay is a Station, or Road
Ships to Anchor in.

8. A *River*, is a ſmall Flux of of Water, flowing within the
d, courting the Banks, whilſt they their Arms diſplay, to
brace her Silver Waves.

9. A *Lake*, is that which continually retains and keeps
ter in it; as the Lake *Zair* in *Africa*, and Lake *Nicaragua* in
erica.

0. A *Gulph*, is an Inlet of the Land, deeper than a Bay, as the
ph of *Venice*, the Gulph of *Florida*; in which are ſwift and ra-
Currents.

Of the Names of the Ocean.

1. The *Ocean*, according to the Four Quarters, had four
nes; as the *Eaſtern* or *Oriental Ocean*; the *Weſtern* or *Oc-*
ntal Ocean, the *Northern* or *Septentrional*; and the *Southern* or
ridionol Ocean; But beſides theſe, it hath other particular
nes according to the Continent it boundeth, and the Nature
the Sea; As it lies extended towards the Eaſt, it is
d the *Chineſe Sea*, from the adjacent Country of *China*;
wards the South, it is called *Oceanus Indicus*, or the
an Sea; Where it waſheth the Coaſt of *Perſia*, it is called
re Perſicum; In like Manner, *Mare Arabicum* from
bia; and ſo towards the Weſt, it is the *Ethiopian Sea*.

Then the *Atlantic Ocean*, from *Atlas* a Mountain in *Afri* But near to *America*, it is called by the *Spaniards*, *Mar-del-No* and on the other Side of *America*, it is *Mar-del-Zur*, or *M* *Pacificum*.

Where it touches upon *Spain*, 'tis *Oceanus Hiſpanicus*; by *Engliſh*, the Bay of *Biſcay*; Between *England* and *France*, called the *Engliſh* Channel; Between *England* and *Ireland*, *Iriſh* Sea, or St. *George*'s Channel; Between *England* and *H* *land*, by ſome the *German*, but rather the *Britiſh* Ocean; Nor ward of *Scotland*, 'tis called *Mare Caledonium*; More Norther 'tis the *Hyperborean*, or *Frozen Sea*; More Eaſterly, 'tis the *T* *tarian* Sea, or *Scythian* Ocean, &c. Thus much for the Nan of the Ocean. Next,

Of the Names of the Seas.

32. The *Baltic* Sea, by the *Dutch* the *Ooſt Zee*, lying betw *Denmark*, *Sweden*, and *Germany*, whoſe Entrance is called *Sound*: The *Mare Mediterraneum*, by the *Engliſh* the *Straits*; the *Spaniards*, *Mar-del Levant*, the Entrance whereof is call the Straits of *Gibraltar*: Then *Pontus Euxinus*, or the *Black S* to which joins *Palus Meotis*, now *Mar-del Zabeche*; Then *Caſpian*, or *Hircanean Sea*: Then the *Arabian Gulf*, *Mare R* *brum*, or the *Red Sea*; And the *Perſian Gulf* or *Gulf de* *catiff*, &c.

Of the Diviſion of the Earthly Globe.

33. The Globe of the Earth (as was ſaid before in *Def.* 1 is divided into four Parts, *viz.* *Europe*, *Aſia*, *Africa*, *America*.

34. *Europe* is bounded towards the North by the Northe Ocean, or *Frozen Sea*; on the South by the *Mediterranean S* lying betwixt it and *Africa*; on the Eaſt with the River *Tana* and on the Weſt by the Weſtern, or *Atlantic* Ocean; wh chief Provinces are,

Poland, *Muſcovia*, *Sweden*, *Norway*,
Denmark, *Germany*, *France*, *Spain*,
Portugal, *Italy*, *Hungary*, *Sclavonia*,
Greece, *Dalmatia*, *Romania*, Part of *Tartaria*.

The principal Iſlands are,

Great Britain, *Ireland*, *Sardinia*, *Sicily*,
Corſica, *Candia*, *Negropont*, *Cyprus*.

35. *Aſia*, is bounded on the North with the Northern, a *Tartarean* Ocean; on the South with the *Arabian Gulf*, or R Sea; on the Eaſt with the *Indian* Ocean; and on the Weſt wi the River *Tanais*.

T

The chief Regions are,
urky in *Aſia*, *Arabia*, *Tartaria*, *Perſia*,
Natolia, *Meſopotamia*, *Aſſyria*, *Chaldea*,
Syria, *Armenia*, *Paleſtina*, *Georgia*,
Media, *Parthia*, *China*, *India*.

The principal Iſlands are,
Japan, *Sumatra*, *Borneo*, &c. in the *Oriental Ocean*.
Cyprus, *Rhodes*, in the *Mediterranean*.
Metelino, *Scio*, *Samos*, &c. in the *Archipelagus*.

36. *Africa* is bounded on the North with the *Mediterranean*, on
Eaſt with the *Red-Sea*, on the South with the *Æthiopic* or
thern Ocean, and on the Weſt with the *Atlantic* Ocean.

The principal Provinces are,
Ægypt, *Barbary*, *Monomotapa*,
Deſerts of *Zara*, *Negroland*, *Biledulgerid*,
Nubia, *Guiney*, *Æthiopia*, or *Abyſſinia*.

It's Iſlands are,
The *Canary* Iſlands, Cape *de Verde* Iſlands,
The Iſles of *Azores*, *Madeira* Iſlands,
St. *Thomas*, *Madagaſcar*, or *St. Lawrence*,
Malta, in the *Mediterranean*, *St. Helena*.

37. *America*, is bounded on the North with the Northern Ocean,
the Eaſt with the *Atlantic* Ocean, on the South with the *Ma-*
lanic Sea, and on the Weſt with the *South-Sea*, or *Mar del Zur* :
divided into two Parts, *viz.* *Mexicana*, and *Peruana*.

Mexicana, or North *America*, hath theſe Provinces ;
New-Spain, *Terra Florida*, *Carolina*, *Virginia* and
Maryland, *Penſilvania*, *New-Jerſey*, *New-York*,
New-England, *New-France*, *Greenland*, whether Continent or Iſland is not yet known.

The chief Iſlands of *Mexicana*, are,
and, or *Iceland*, *California*, *New-found-land*, *Bermudas*, this by lateſt Accounts ſeems to be a Peninſula.

Peruana or *South America*, hath theſe Provinces ;
rra Magellanica, *Brazilia*, *Chili*, The *Amazons*, *Guiana*,
Peru, *Panama*, *Carthagena*, *Peragua*, or *Rio-de-la-Plata*.

The principal Iſlands of *Peruana*, are,
rra del Fuego, *Hiſpaniola*, *Cuba*, *Jamaica*, *Porto Rico*, *Bahama*,
Bermudas, *Barbadoes*, and the reſt of the *Caribbee-Iſlands*, &c.
Moluque or *Molucca Iſlands*, *Java-Major*, *Java* the leſs, and
ny other Iſlands in the *Eaſt-Indies*.

Having deſcribed the Lines and Circles, and the Parts belo ing to the Terreſtrial Globe, the Uſes of all take in the follow Problems.

Problem 1. *To find the Latitude of any Place upon the Globe.*

The Rule. Bring the propoſed Place juſt under the Braſs Me dian, and note what Degree (on the ſaid Meridian) ſtands agai it, which is the Latitude thereof. Or thus,

With a pair of Compaſſes, take the neareſt Diſtance from t propoſed Place (on the Globe) to any Parallel of Latitude, a lay it on the graduated, or firſt Meridian from the ſaid Parall the ſame Way the propoſed Place lieth from it, the other Fo ſheweth the Latitude required.

Example. *Let it be required to find the Latitude of the* Liza *in* England?

Turn the Body of the Globe 'till the *Lizard* be juſt under t Braſs Meridian, and you'll find 49d. 57m. right againſt it; whi is the Latitude of the *Lizard*. Or thus,

Take the neareſt Diſtance (on the Globe) from the *Lizard* any Parallel of Latitude; apply the ſame to the graduated Me dian, and it ſheweth the Latitude 49d. 57m. as before.

Note; All thoſe Circles on the Globe, which are parallel to t Equator, are called Parallels of Latitude.

Problem 2. *To find the Longitude of any Place on the Globe.*

The Rule. 1. Turn (as before) the Globe 'till the propoſ Place lies juſt under the Braſs Meridian, and there keep it ſteady

2. Then obſerve what Degree of the Equator lieth under th Braſs Meridian, and that's the Longitude required.

Example. *I demand the Longitude of the* Lizard *in* England?

Bring the *Lizard* under the Braſs Meridian, and then the Bra Meridian cutteth the Equator, in 18d. 22m. the Longitude required.

Note; The Globes formerly made in *England* begun Longitud at the Meridian of the Iſland of St. *Michael*, one of the Weſter or *Azore* Iſles, which is Weſt from the Meridian of *London* (according to the *Mariner's Compaſs Rectified*, and alſo the *Mariner Calendar*) 23d. 36m.

And accordingly the *Lizard*'s Longitude is 5d. 14m. Weſt fro *London*: This Difference in the Longitude of Places, is occaſioned by the different Beginnings of Longitude by different Authors, which the Student is deſired to conſider.

Problem 3. *To find the Diſtance of any two Places on the Globe:*

The Rule. 1. Lay the Beginning of the Degrees on the Qua- rant of Altitude, upon one of the propoſed Places, and count ow many Degrees on it, are contained between both Places, hich is the Diſtance required.

2. Thoſe Degrees being multiplied by 60 for Nautic, and 70 r Geographic Miles, the Product is the Diſtance in Minutes. r thus,

Take the Diſtance between the two Places with a Pair of Com- ſſes; then meaſure that Diſtance on the Equator, counting the egrees intercepted between both Feet, and it will ſhew the Di- nce required.

Note; The Diſtance found by this *Problem*, is the ſhorteſt Di- nce; or their Diſtance in the Arc of a Great Circle, which is ſs than their Diſtance in the Rumb, leading from one to the her; except both Places lie under one Meridian, or in the quator.

Example. *I demand the Diſtance between the* Lizard *and the land of* Barbadoes.

If you lay the Edge of the Quadrant of Altitude on both Places, d the Beginning of the Degrees of it on one of the Places, you ill find on the Quadrant of Altitude 57 Degrees intercepted be- een them, which is the Diſtance; and being multiplied by 60 70, gives 3420 Nautic, or 3990 Geographic Miles.

oblem 4. *To find the Angle of Poſition of Places; that is, The Angle, the Arc of a Great Circle paſſing over two given Places, makes with the Meridian of either of them.*

The Rule. 1. Rectify the Body of the Globe to the Latitude of e of the given Places.

2. Bring the ſame Place under the Braſs Meridian, and there y the Body of the Globe.

3. Screw the Quadrant of Altitude faſt on the Braſs Meridian, ht over the ſaid Place.

4. Then lay the graduated Edge of the Quadrant of Altitude the other Place, and the ſaid Edge will cut the Horizon in the egree of Poſition required.

Example. *Let it be required to know the Angle of Poſition of* rbadoes *from the* Lizard?

1. Bring the *Lizard* to the Braſs Meridian, and there reſting Body of the Globe, you will find the Latitude of the *Lizard* be 49d. 57m.

2. Move the Braſs Meridian (keeping the Body of the Glob fixed as before) higher or lower, until 49d. 57m. on it do cut th Horizon (on the North-ſide thereof,) then is the Globe rectifie to the Latitude of the *Lizard:* The like you muſt do in rectifying the Globe for any other Place, or Latitude.

3. Screw the Quadrant of Altitude to 49d. 57m. on the Braſ Meridian, which is juſt over the *Lizard*, (if the Globe be not returned from its Poſition as in the firſt Step hereof,) and turn th graduated Edge of it to *Barbadoes*, the ſaid Edge will point on th Horizon to 69 Degrees South Weſterly; which is the Angle o Poſition of *Barbadoes* from the *Lizard*; that is, the Angle, th Arc of a great Circle paſſing through, or over the two Places makes with the Meridian of the *Lizard*, which is not the Rumb leading from the firſt to the ſecond; For, if you rectify the Globe to the Latitude of *Barbadoes*, and ſo proceed as before directed, yo will find the Angle of Poſition to be 38 Degrees North-Eaſterly the Poſition of the *Lizard* from *Barbadoes*, which is 31 Degree leſs than the Poſition of *Barbadoes* from the *Lizard*; whereby i appears neither of theſe are the true Rumb, or Point of the Compaſs leading from one Place to the other: For you are to *Note*;

1. That the Rumb-lines, or Points of the Compaſs, make equal Angles with all Meridians on the Globe.
2. That an equal Segment, or Part of the ſaid Rumb, changeth or altereth the Latitude in all Places equally.
3. That the Rumb Lines, tho' continued never ſo far, do no paſs into, or through the Poles, but wind about them 'till they loſe themſelves.
4. Theſe Rumb Lines are repreſented upon the Globe by thoſ Spiral-Lines, which you ſee are 32 in Number, meeting in a Center, where there is a *Flower-de-Luce* pointing to the North from thence they run winding about the Globe, and continue inclining towards the Pole, where they ſeem confuſed.

Problem 5. *Two Places being given; to find their Rumb, Bearing, or Courſe in ſailing from one to another.*

The Rule, 1. Having found the two Places on the Globe, ſe what Rumb-Line paſſeth through both of them, and that is th Rumb, or Courſe from one to another.

2. If no Rumb-Line paſs through both Places, then obſerv that which runneth parallel to both Places, and that is the Rumb or Courſe from one to the other.

Exampl

:xample 1. *I demand the Courſe from the* Lizard *to* Cape Cod
New England?
)n the Globe you will find theſe Places to lie on the W. by
and E. by N. Rumb Line, and therefore the Courſe from the
ard to *Cape Cod*, is W. by S. and conſequently from *Cape Cod*
he *Lizard* E. by N.

:xample 2. *I demand the Courſe from the* Lizard, *to the Iſland*
badoes?
ere no Rumb-Line on the Globe paſſeth over them; where-
look for a Rumb to which the Place lies moſt parallel, and
ll find it S. W. half W. the Courſe from the *Lizard* to I.
badoes; and NE. half E. from I. *Barbadoes* to the *Lizard.*

lem 6. *Courſe and Diſtance ſailed being given; to find the*
Difference of Latitude and Difference of Longitude.

he Rule. 1. Make a ſmall Mark on that Rumb Line (which
e given Courſe) in the Latitude of the Place you ſail from,
g that Mark to the Braſs Meridian, and it cuts the Equator
Longitude.

Take the Diſtance ſailed from the Equator; and lay it on
ſaid Rumb, from the foreſaid Mark; at the Termination
of make another Mark.

Then bring the Second Mark to the Braſs Meridian, which
e Latitude of that Place; and then the Meridian cuts the
tor in the Longitude of it.

Having the Latitude and Longitude of thoſe two Places
ed in the Rumb Line, by Subtraction you may find their
rence of Latitude and Difference of Longitude, and it is
.

ample. *Suppoſe a Ship ſails* S. W. *by* W. 200 *Leagues, or*
Degrees from the Lizard: *I demand her Difference of Lati-*
and Difference of Longitude; or what Latitude and Longi-
ſhe is in?

Make a Mark on the S. W. by W. Rumb, juſt under 49d.
. (the *Lizard*'s Latitude) and then the Meridian cuts the
tor in 5d. 14m. W. the Longitude of that Mark.

Take 10 Degrees from the Equator, and lay it on the
. by W. Rumb, from the Firſt Mark to the Second Mark.

Bring the ſecond Mark to the Braſs Meridian, and the
ude of it, is 44d. 40m. the Lat. the Ship is in, and in the
tor the Long. of it is 17d. 59m. W. by Subtraction, the
of Lat. is 5d. 17m. and Diff of Long. is 12d. 45m. Lon-
e in this, and all the ſucceeding Problems being eſtimated
the Meridian of *London*: But here you muſt note;

That, The Diſtance ſailed intirely taken, and laid on t Rumb, is the Diſtance in the Arc of a Great Circle, and r really in the Rumb; for the Diſtance in the Great Circle always leſs than the Diſtance in the Rumb; Wherefore, the b ter way will be, to take 1, 2, 3, (or ſome ſmall Number of) D grees of the Equator; aud run that Diſtance (in the Compaſſ over, upon the Rumb Line, from the Firſt Mark to the Secon and in ſo doing, the Diſtance is more truly laid, than by taking at once.

Problem 7. *Both Latitudes and Courſe given; to find the Diſta and Difference of Longitude.*

The Rule. 1. Turn the Body of the Globe 'till the given Ru doth cut the Braſs Meridian in the Latitude you depart from, a there make a Mark on the Rumb, and at the ſame Time, what Degree of the Equator is cut by the Meridian; for that the Longitude of this Mark.

2. Turn the Body of the Globe 'till the ſame Rumb cuts t Meridian in the Latitude of the ſecond Place, and there ma another Mark on the Rumb; then ſee what Degree of the Equ tor is cut by the Meridian, which is the Longitude of the ſeco Mark; and the leſs Longitude ſubtracted from the greater, gi the Difference of Longitude required.

3. The Diſtance between the two Marks on the Rumb-Lin being meaſured (according to the Note in the laſt *Problem*) on t Equator, gives the Diſtance of the two Places.

Example. *If a Ship ſails* SW. *by* W. *from the* Lizard, *'till Obſervation ſhe is in Latitude* 44d. 40m. North; *I demand h Diſtance ſailed, and what Longitude ſhe is in?*

1. Bring the S W. by W. Rumb to cut the Meridian in 49 57m. the *Lizard's* Latitude, and make a Mark on that Run there, then the Meridian cuts the Equator in 5d. 14m. W. t Longitude of that Mark.

2. Turning the Globe 'till the S W. by W. Rumb cuts t Meridian in 44d. 40m. the Latitude of the ſecond Place, a making there a Mark on the Rumb; then the Meridian cuts t Equator in 17d. 59m. W. the *Longitude* of the ſecond Mark; A therefore the *Difference of Longitude*, is 12d. 45m. Weſt; whi being added to the Longitude of the *Lizard*, 5d. 14m. W. t Sum is 17d. 59m. W. the Longitude the Ship is in.

3. Take 2 Degrees from the Equator. and run over th Diſtance in the Compaſſes upon the Rumb, from the fi

ark to the Second, and 'tis five Times, which is 10d. or 200 eagues, the Diſtance ſailed on that Rumb.

oblem 8. *Having the Latitude, and Longitude the Ship is in given; to find the Place where the Ship is in, on the Globe.*

The Rule. 1. Bring the Longitude to the Braſs Meridian, and ere ſtay the Body of the Globe.

2. Where the given Latitude cuts the Globe, make a Mark on e Body of the Globe, which Mark is the Place of the Ship at at Time.

Example. *If a Ship ſails* S. W.ly. *from the* Lizard, *and after e Time is in Latitude* 44d. 40m. *and Longitude* 17d. 59m. W. *lemand the Place of the Ship on the Globe?*

1. Bring 17d. 59m. W. on the Equator to the Braſs Meridian, l there ſtay the Globe.

2. Juſt under 44d. 40m. N. on the Braſs Meridian, make a rk on the Body of the Globe, and that is the Place of the p at that Time.

Section III. *The Deſcription of the* Cœleſtial Globe.

HE *Cœleſtial Globe* repreſents that glorious Canopy, ſo richly embroider'd and beſet with thoſe ſparkling Diamonds, upon the duſky Cheeks of the Night hang as rich Jewels in *Ethiopian*'s Ear; having upon it's Convexity artificially placed the Stars, correſpondent to their Natural Situation in the Conty of the Orb, which we call the *Starry Heavens.*

. The Appurtenances belonging to this, are the ſame with e belonging to the Terreſtrial Globe; and being before deed in *Section* 1. of this *Chapter*, I refer you to it.

. On the Body of the Globe, beſides the Conſtellations, e are drawn diverſe Circles; as the *Equinoctial*, *Ecliptic*, *Co*, *Meridians*, and *Circles of Longitude*; All theſe are called at Circles. The Leſſer Circles are the *Tropics*, *Polar Circles*, *Parallels of Declination.*

. The *Equinoctial* in this, is the ſame with the *Equator* in the *eſtrial Globe*, and in the ſame Manner divided, and number'd the Left-hand towards the Right, with 10, 20, 30, *&c.* to Degrees.

he *Poles* of the *Equinoctial* are alſo called the *Poles* of the *ld*, and are repreſented by the two Wires on which the Body e Globe turneth.

5. The *Ecliptic* is a great Circle which croſſeth the Equ noctial in two oppoſite Points, the Beginning of *Aries*, ar *Libra*; it is divided into twelve (equal Parts called) Signs, eac containing 30 Degrees, and figured from the Left-hand towar the Right, 10, 20, 30; then 10, 20, 30, *&c.* having th Figure, Character, and Name of each Sign, as followeth;

Aries	♈	Northern Signs	*Libra*	♎	Southern Signs.
Taurus	♉		*Scorpio*	♏	
Gemini	♊		*Sagittarius*	♐	
Cancer	♋		*Capricornus*	♑	
Leo	♌		*Aquarius*	♒	
Virgo	♍		*Piſces*	♓	

This Circle with its Figures and Characters, are on bo Globes; but the Cœleſtial hath the Images and Names of t Signs, which the Terreſtrial hath not.

Under this Circle the Sun moves in his Annual Courſe; b the reſt of the Planets have their Deviations from it; for whi Reaſon *Aſtronomers* have aſſigned Eight Degrees on each Side t *Ecliptic*, making the whole Latitude to be 16 Degrees, whi Breadth is called the *Zodiac*.

The *Zodiac* is not drawn on the Globe, only imagined two Circles parallel to the *Ecliptic*, at eight Degrees Diſtance fro it, on each Side thereof.

The *Poles* of the *Ecliptic*, are two oppoſite Points, each 2 29m. diſtant from its correſpondent Pole of the World: In th the Circles of Longitude all meet, and near each is writ *Po Eclipticus*.

6. The *Meridians* are the ſame as before on the Terreſtri Globe, only with this Difference, on this they are drawn throu every 30th Degree of the Equinoctial, on that through eve 15th Degree of the Equator; in both, they all meet in the Pol of the World..

7. The *Colures*, are two Meridians, cutting each other Right-angles in the Poles of the World, dividing the Equinoct and Ecliptic into 4 equal Parts; the one paſſeth thro' the begi ning of *Aries* and *Libra*, the two Equinoctial Signs; therefo called the Equinoctial Colure; and on the Globe it is divid into Degrees, numbred from the Equinoctial both Ways, 1 20, 30, *&c.* ending in 90 at each Pole of the World: It ge nerally hath theſe Words near it, *Colurus Equinoctiorum*.

The other paſſeth through the beginning of *Cancer* and *C*

prico

corn, the two Solſtitial Signs, therefore called the *Solſtitial*
lure; This paſſeth through the Poles of the World, and Poles
the Ecliptic: 'Tis diſtinguiſhed on the Globe by theſe Words,
lurus Solſtitiorum.

8. The *Horizon* is a great Circle 90 deg. diſtant from the
nith, and Nadir, cutting all Azimuth Circles at Right-
igles, and divided the World into two equal Parts, the up-
r and viſible Hemiſphere, and the lower and inviſible: 'Tis
reſented by the upper Side of the wooden Frame, on which is
double Calendar of Months and Days, according to the Old
d New Stile, with the Winds or Points of the Compaſs, and
ircle of Signs with their Degrees.

The *Zenith*, and *Nadir*, are two Points diametrically oppo-
, and are the Poles of the Horizon: The Zenith is the *Ver-*
il Point, or Point over Head; the Nadir is directly oppoſite
reto.

9. The *Azimuths* or *Vertical Circles*, are Great Circles in-
ſecting each other in the Zenith and Nadir, and cutting the
rizon at Right Angles; Theſe Circles are not drawn on the
dy of the Globe, but are repreſented by the Quadrant of Al-
ide, when 'tis ſcrew'd in the Zenith.

10. *Circles of Longitude*, are great Circles interſecting each
ier in the Poles of the Ecliptic, and cut it at Right Angles;
ieſe are repreſented by the Quadrant of Altitude when it is
ew'd over the Poles of the Ecliptic; and on the Body of ſome
obes; 12 of theſe Circles are drawn, paſſing through the
ginning of the Twelve Signs.

Thus much for the Great Circle.

The Deſcription of the Leſs Circles.

Leſs or *Small Circles*, are thoſe which divide the Globe
o two Unequal Parts, and are parallel to ſome Great Cir-
s, therefore called *Parallel Circles*, and are of three Kinds,
. Parallels of Declination, *Parallels of Altitude*, and *Parallels*
Latitude.

11. *Parallels of Declination*, are parallel to the Equinoc-
, imagined to paſs through every Degree and Minute of
Meridians, between the Equinoctial and each Pole of the
orld, and are the ſame with the Parallels of Latitude on the
rreſtrial Globe.

The *Tropics* and *Polar Circles*, are Parallels of Declina-
n, and the ſame as before in the Deſcription of the Terreſtrial
obe.

12. *Almicanters*, or *Parallels of Altitude*, are parallel to the Horizon, imagin'd to paſs thro' every Degree and Minute of an Azimuth Circle, and alſo of the Meridian of a Place, between the Horizon and the Zenith of that Place: Theſe are deſcribed by the Diviſions or Graduations on the Quadrant of Altitude in its Motion about the Body of the Globe, when it is ſcrew'd in the Zenith of any Place.

13. *Parallels of Latitude*, are ſmall Circles parallel to the Eclip-tic, imagined to paſs through every Degree and Minute of the Colures, or any Circle of Longitude, between the Ecliptic and the Poles thereof: Theſe are repreſented by the Diviſions of the Quadrant of Altitude in its Motion round the Body of the Globe, when it is ſcrew'd over the Poles of the Ecliptic.

Having deſcribed the imaginary Circles of the Cœleſtial Globe, we proceed now to the Deſcription of the Stars, thoſe gloriou Diamonds, ſparkling in the immenſe Expanſion of the Firmament, encircling the Terreſtrial Orb at unmeaſurable Diſtances which for Multitude ſeem innumerable, yet the greateſt and more viſible may be number'd, and nam'd: And for this Purpoſe *Aſtronomers* (for Order, and Method-ſake) have reduced many Star into one Image, or Conſtellation, the better to know where to find them; and being found, how to expreſs them.

14. The Number of Conſtellations commonly drawn on the Body of the Cœleſtial Globe, are 66, and are as followeth:

The *Northern Conſtellations are* 23, viz.

	Stars		Star
1. *Urſa Minor*	9	12. *Auriga*	1
2. *Urſa Major*	33	13. *Serpentarius*	2
3. *Draco*	36	14. *Serpens*	1
4. *Cepheus*	11	15. *Sagitta*	
5. *Bootes*	22	16. *Aquila*	
6. *Corona Borealis*	8	17. *Antinous*	
7. *Hercules*	30	18. *Delphinus*	1
8. *Lyra*	10	19. *Equuleus*	
9. *Olon*, or *Cygnus*	27	20. *Pegaſus*	2
10. *Caſſiopeia*	23	21. *Andromeda*	2
11. *Perſeus*, and *Caput Meduſæ*	27	22. *Triangulum*	
		23. *Coma Berenices*	1

In all 38

Th

The *Zodiacal Conſtellations* are 12, *viz.*

	Stars		Stars
Aries	16	7. *Libra*	10
Taurus	32	8. *Scorpio*	26
Gemini	24	9. *Sagittarius*	29
Cancer	16	10. *Capricornus*	21
Leo	33	11. *Aquarius*	34
Virgo	39	12. *Piſces*	34

In all 314

The *Southern Conſtellations* are 30, *viz.*

	Stars		Stars
Cetus	26	17. *Columbus*	10
Orion	39	18. *Piſcis Auſtrinus*	11
Flumen Eridanus	43	19. *Grus*	13
Lepus	13	20. *Phænix*	12
Canis major	13	21. *Indus*	12
Canis minor, or *Canicula*	2	22. *Pavo*	16
Argo Navis	42	23. *Avis Indica*, *Touehan*	7
Robur Corolinum	11	24. *Apus muſca*	3
Hydra	27	25. *Chamæleon*	10
Crater	8	26. *Triangulum Auſtrale*	5
Corvus	7	27. *Piſcis Volans*	7
Centaurus	30	28. *Dorado*, *Piſcis Auratus*	7
Lupus	22	29. *Apous*, *Anſer Americanus*	10
Croſero, or *Croſiers*	5	30. *Hydra*, *Serpens Auſtrina*	10
Ara, or the *Altar*	8		
Corona Auſtrina	10		

In all 439

The Sixty-ſixth Conſtellation (lying near the *Urſa major*) was
ded by Sir *Charles Scarborough*, and called *Cor Caroli*, being one
r in a crowned Heart, and compleats a Catalogue of 1137 fixed
rs as above: But this Number is now largely encreas'd by the
ſervation of our modern Aſtronomers, as may be ſeen in the
mſteedian Catalogue, which contains about 3500, forming ſe-
al new Aſteriſms, and are diſtinguiſhed into Six Degrees of
agnitude, or Bigneſs; The biggeſt, and brighteſt are called
rs of the firſt *Magnitude*; thoſe next inferior in Bigneſs, and
ightneſs, are Stars of the Second *Magnitude*, &c. unto Stars
the Sixth *Magnitude*: Theſe ſeveral Magnitudes are expreſſed
the Globe in their ſeveral Forms, as may be ſeen in a little
able placed on the Globes, and intituled *Stellarum Magnitudines*.

Section IV. *The Uſe of the* Cœleſtial Globe.

BEfore the working of any *Problem* on this Globe, it will I neceſſary to explain ſeveral Technic Terms made uſe of *Aſtronomy*, and *Geography*, as contained in theſe followi Definitions.

1. *Altitude*, is an Arc of an Azimuth Circle, contain between the Horizon and any Parallel of Altitude; 'Tis count on the Braſs Quadrant of Altitudes, which repreſents any Az muth Circle on the Globe.

2. *Aſcenſion*, is the riſing of the Sun or Star, or any Pa of the *Equinoctial* above the Horizon; and *Deſcenſion* is t Setting thereof.

3. *Right Aſcenſion*, is an Arc of the *Equinoctial*, intercept between the beginning of *Aries*, and any Meridian, and count according to the Order and Succeſſion of the Signs; or, that Degree and Minute of the Equinoctial, (counted as befo which cometh to the Meridian with the Sun, Star, or with a Point of the Heavens.

4. *Oblique Aſcenſion*, is that Degree and Minute of the Eq noctial, (counted as before) which riſeth with the Center of t Sun, or Star, or with any Point of the Heavens; and *Obliq Deſcenſion* is the Setting thereof.

5. *Aſcenſional Difference*, is the Difference between t *Right* and *Oblique Aſcenſion*, or *Deſcenſion*; or, it is t Space of Time the Sun Riſeth, or Setteth before, or after of the Clock.

6. *Amplitude*, is an Arc of the Horizon comprehended b tween the true Eaſt or Weſt Points of it, and the Center of t Sun, or Star, at their Riſing or Setting.

7. *Azimuth*, is an Arc of the Horizon contained betwe the Meridian of the Place, and an Azimuth Circle paſſi thro' the Cœleſtial Object.

8. *Declination*, is an Arc of the Meridian, comprehen between the Equinoctial, and the Center of the Sun or Star, any Point of the Heavens: It is North Declination on the No Side of the Equinoctial, but South Declination when on South Side thereof; and is counted on the Braſs Meridian the Globe, or on the Equinoctial Colure.

9. *Hour of the Day, or Night*, is an Arc of the Equin tial, contained between the Meridian of the Place, and an ther Meridian paſſing through the Center of the Sun at a Time: This is counted on the Braſs Hour Circle, which

divi

vided into the 24 Hours of the Day and Night, and hath a
tle Braſs Index pointing to them as the Globe is turned about;
it is counted on the Equinoctial, Reckoning 15d. to an Hour.

10. *Latitude of a Comet, Planet, or Star*, is an Arc of a Circle
Longitude, contained between the Ecliptic and the Comet,
lanet or Star's Center; that is counted on the Braſs Quadrant
Altitude, when ſcrew'd over the Pole of the Ecliptic, for
en it repreſents a Circle of Longitude.

11. *Latitude of a Place*, or *Latitude upon the Earth*, is an
rc of the Meridian of that Place, contained between the
quator and that Place; Equal to which, is the Height of the
ole (of the World) above the Horizon. This is counted on
e Braſs Meridian of the Globe; or may be counted on the
aduated Meridian on the Body of the Globe;

So that *Latitude in the Heavens*, and *Latitude on the Earth*,
e different things; one being an Arc of a Circle of Longi-
ide, and applicable to all Cœleſtial Objects except the Sun,
hich hath no Latitude; the other an Arc of a Meridian,
nd applicable to Places on the *Earth*.

12. *Longitude in the Heavens*, is an Arc of the Ecliptic,
omprehended between the Beginning of *Aries*, and that Circle
f Longitude which paſſeth through the Center of the Sun,
tar, or any Point of the Heavens, and counted according to the
ucceſſion of the Signs.

13. *The Place of the Sun, or of a Star, with reſpect to the
cliptic* is the Sign, (and Degree, and Minute of that Sign)
e Sun, or Star is in.

14. *Longitude of any Cœleſtial Object, from the neareſt Equi-
ctial Point* is how many Degrees and Minutes, the Sun or
tar is from the Beginning of *Aries* or *Libra*, either before or
fter them; which can never be more than 180 Degrees.

15. *Longitude on the Earth*, is an Arc of the Equator, com-
rehended between the Meridian of any Place, and that Meridian
vhere Longitude takes it Beginning.

So that *Longitude in the Heavens*, and *Longitude on the Earth*
re vaſtly different; one being an Arc of the Ecliptic, the other
n Arc of the Equator.

16. *Meridian of a Place*, is that Meridian which paſſeth over
he Zenith of that Place; to which when the Sun cometh, 'tis
ither Noon or Midnight; at the Firſt, he is at his higheſt
ltitude above the Horizon; and at the Laſt, he is at the loweſt
epreſſion for that Natural Day.

In like Manner, any Star or Planet coming to the Meridian of any Place, is then at the higheſt Altitude, or loweſt Depreſſion.

Theſe Things being well conſider'd, the following *Problems* will be the better underſtood.

Problem 9. *The Day of the Month given: To find the Sun's Place in the Ecliptic.*

The Rule. 1. Seek the Day of the Month, (in either Account, according to the *Julian*, or *Gregorian*, as you find them placed in the *Calendar*) on the upper Side of the Horizon.

2. Right againſt it, in the innermoſt Circle, is the Sign, Degree, and Minute, the Sun will be in that Day at Noon.

Example. *The 8th Day of* January *in the* Julian, *or the* 19*th the* Gregorian Account, *I demand the Sun's Place in the Ecliptic?*

Right againſt the 19th of *January*, in the *Gregorian* Calendar, in the innermoſt graduated Circle, are 29 Degrees of *Capricorn*, in which Sign and Degree the Sun will be on the ſaid 19th of *January*, *New Stile*, or the 8th of *January*, *Old Stile*; the like Method to be obſerved for any other Day.

Problem 10. *How to rectify the Globe for any Latitude, and to make it fit for Uſe, at any given Time.*

The Rule. 1. The Globe being placed in the Frame, by putting the Braſs Meridian into the two Notches, that are in the North and South Parts of the Horizon, ſo that the graduated Side thereof be towards the Eaſt, and the North Pole towards the North Part of the Horizon, the Globe alſo reſting in the Notch, that is in the Bottom of the Frame; move the ſaid Meridian higher or lower, till the given Latitude in it doth juſt touch the upper Part of the Horizon, on the North Side thereof, if North Latitude, but the South Side, when South Latitude.

2. Place the Braſs Hour Circle about the Pole, ſo that the Hours of 12 and 12 lie directly over the graduated Side of the Braſs Meridian; and put the little Index on the Axis, ſo that it may move about freely as you turn the Globe; then doth the upper 12 on the Hour Circle repreſent 12 at Noon, and the lower 12 at Midnight; and all the other Figures, the correſpondent Hours of the Day and Night.

3. By *Problem* 9. Find the Sun's Place according to the given Time; then ſeek the Sun's Place in the Ecliptic, on the Body of the Globe, and bring that Degree to the Meridian; there ſtay the Globe, and then turn the little Index till it points juſt at the upper 12 in the Hour Circle.

Thus,

hus is the Globe rectify'd to the given Latitude, and the Hour le and Index to the given Time, *viz.* the Noon of that Day.

xample. *At* London *the* 19*th of* January, New-Stile, *I would e the Globe rectify'd fit for Uſe.*

. Move the Braſs Meridian 'till 51d. 31m. thereupon, juſt h the North Part of the Horizon.

. By *Problem* 9. The Sun's Place is 29d. in ♑, which being d in the Ecliptic on the Globe, bring it to the Braſs Meridian, there reſting the Globe, turn the little Index to the upper 12 he Hour Circle; and fix it ſo, that it may move freely with Globe, and 'tis done.

blem 11. *The Day of the Month given; to find the Sun's Declination.*

he Rule. 1. By *Problem* 9. Find the Sun's Place in the Eclip- on the Wooden Horizon.

. Bring the Sun's Place (in the Ecliptic, found by *Prob.* 10. the Globe) to the Braſs Meridian, on which, and right over Sun's Place is his Declination required.

xample. *The* 19*th of* January, New-Stile; *I deſire to know Sun's Declination?*

1. The Sun's Place in the Ecliptic, for the 19th of *January* und by *Problem* 9.) is 29d. in ♑.

. Bring 29d. in ♑ (in the Ecliptic on the Globe) to the Braſs ridian, and then right over it (on the Braſs Meridian) is 20d. n. which is the Sun's Declination, South decreaſing. Or thus,

. With a Pair of Compaſſes take the neareſt Diſtance from Sun's Place in the Ecliptic 29d. in ♑, to the Equinoctial on Globe.

2. Meaſure that Diſtance on the Equinoctial Colure (if gra- ted) and it ſheweth the Declination 20d. 20m. as before.

blem 12. *The Day of the Month given; to find the Sun's Right Aſcenſion.*

he Rule. 1. As before, find the Sun's Place in the Ecliptic, *Problem* 9.

2. Bring the Sun's Place (as is directed in *Problem* 11.) to the aſs Meridian; look what Degree of the Equinoctial is cut by and that is the Sun's Right Aſcenſion required.

Example. *The* 19*th of* January; *I demand the Sun's Right cenſion?*

1. The 19th of *January*, his Place in the Ecliptic is 29d. in , by *Problem* 9.

2. His Place of 29d. in ♑, being brought to the Braſs-Mer dian, it cuts the Equinoctial in 301d. 30m. the Sun's Rig Aſcenſion.

Problem 13. *The Latitude of a Place, and the Day of the Mon given; to find the Time of the Sun's Riſing, Setting, and h Amplitude?*

The Rule. 1. Rectify the Globe (by *Problem* 10th, fit f Uſe) according to the given Latitude, and given Time.

2. Bring the Sun's Place (in the Ecliptic on the Globe) dow to the Horizon on the Eaſt Side thereof, and then the little Inde will point to the Sun's Riſing in the Hour Circle; and th Body of the Globe ſtayed there, look what Degree of the Horizon (counted from the Eaſt Point thereof) ſtandeth righ againſt his Place (in the Ecliptic on the Globe) that is the Sun Amplitude at his Riſing.

In like manner, turn the Globe 'till you bring the Sun Place to lie even with the Weſt Side of the Horizon, ſtaying th Body of the Globe there; then will the Index point to h Setting, and againſt his Place on the Globe ſtandeth his Amplitude (on the Horizon) counted from the Weſt Point thereof.

Example. *The* 19*th of* January *at* London*: I demand th Time of the Sun's Riſing and Setting, and his Amplitude?*

1. The Globe being elevated to the Latitude of 51d. 31m bring 29d. in ♑, to the Braſs Meridian, and fix the Index at th upper 12, then 'tis rectified to the given Latitude, and give Time.

2. Bring 29d. in ♑, to the Eaſt Side of the Horizon, an ſtaying the Globe there, the Index Points to 7 Hours 3 quarters that is, 3 quarters after 7 is the Sun's Riſing: and againſt 29 in ♑, is 33d. 50m. on the Horizon, (from the Eaſt towar the South) which is the Sun's Amplitude at Riſing.

In like manner turn the Globe 'till you bring 29d. in ♑, t the Weſt Side of the Horizon, and the Index Points to a quarte after 4, which is the Sun's Setting; and in the Horizon yo have his Amplitude (the ſame as before) 33d. 50m. from th Weſt (towards the South) which is the Sun's Amplitude Setting.

Problem 14. *The Latitude of a Place, and the Day of the Mon given; to find the Sun's Oblique Aſcenſion and Deſcenſion?*

The Rule. 1. Rectify the Globe to the given Latitude, an find the Sun's Place in the Ecliptic for the given Time.

2. Bring the Sun's Place in the Ecliptic on the Globe, to the
ſt Side of the Horizon, and then ſee what Degree of the Equi-
ctial is cut by the Horizon, and that is the Sun's Oblique
cenſion.

3. In like manner bring the Sun's Place in the Ecliptic to the
eſt Side of the Horizon, and it ſheweth his Oblique De-
nſion.

Example. *The 6th of* February, New-Stile, *at* London: *I de-
nd the Sun's Oblique Aſcenſion and Deſcenſion?*

1. Rectify the Globe to the given Latitude 51d. 31m. accord-
to Problem 10.

2. Bring 17d. 30m. of ♒ (the Sun's Place for the 6th of
bruary) to the Eaſt Side of the Horizon, and then it cuts the
uinoctial in 340d. 20m. which is the Sun's Oblique Aſcenſion.

3. Bring 17d. 36m. of ♒ to the Weſt Side of the Horizon, it
s the Equinoctial in 299d. 15m. which is the Sun's Oblique
ſcenſion.

ob. 15. *The Latitude of a Place, and Day of the Month given;
to find the Sun's Altitude, and Azimuth at any Time of the Day.*

The Rule. 1. Rectify the Globe and Hour-Index, as before,
Problem 10.

2. Screw the Quadrant of Altitude in the Zenith; which I
l rectifying the Quadrant of Altitude to the Latitude of the
ce.

3. Turn the Globe 'till the Index point to the given Hour of
Day, and there ſtay the Globe.

4. Move the Quadrant of Altitude, 'till the graduated Edge
it lies juſt on the Sun's Place in the Ecliptic on the Globe,
d there ſtay it.

5. Look what Degree on the Quadrant of Altitude is againſt
Sun's Place, and that is the Sun's Altitude.

6. Look what Degree of the Horizon is cut by the graduated
lge of the Quadrant of Altitude, counted from the North, or
m the South, and that is the Sun's Azimuth.

Example. *On the* 21ſt *of* December, *in the Latitude of* 20*d.
m.* N. *at half an Hour paſt Nine in the Morning: I demand the
n's Altitude, and Azimuth?*

1. The Globe being Rectified (by *Problem* 10.) turn it about
l the Hour Index points to half an Hour after 9 in the Morn-
, and there ſtay the Body of the Globe.

2. Screw the Quadrant of Altitude on 20d. 11m. (on the
aſs Meridian) which is the Zenith, or Diſtance of that Place
m the Equinoctial.

Note; In ſcrewing the Quadrant of Altitude on the Braſs M
ridian, you muſt put the Screw Side of the Notch, on the Ba
ſide thereof, and put it cloſe down; ſo cloſe to it, that the t
Plate may be as near the Body of the Globe as poſſible; yet
as not to obſtruct its Motion.

Alſo mind that you ſet the ſloped Edge of the Notch to
Latitude of the given Place.

3. Bring the graduated Edge of the Quadrant of Altitude,
the firſt Scruple of ♑, the Sun's Place (for *December* the 21ſt)
the Ecliptic, and then on the Quadrant of Altitude (againſt it)
34d. 15m. his Altitude at half an Hour paſt Nine of the Clo
in the Morning.

4. And the Quadrant of Altitude cuts the Horizon in 44
nearly from the South Eaſtward, which is the Sun's Azimuth
the ſame Time.

Problem 16. *The Latitude of a Place, the Day of the Month, a*
Sun's Altitude given; to find his Azimuth, and Hour of the Day

The Rule. 1. Rectify the Globe, Hour Index, and Quadra
of Altitude, as before.

2. Turn the Body of the Globe, and move the Quadrant
Altitude, 'till you bring the Sun's Place in the Ecliptic to lie ju
under his Altitude on the Quadrant; there ſtay them both.

3. Then will the graduated Edge of the Quadrant point o
the Azimuth, in the Horizon from the North, or South; an
the Index ſheweth the Hour of the Day.

Example. *At* London *the* 11*th of* Auguſt, *in the Forenoon, t*
Sun's Altitude being 11d. 30m. *I demand his Azimuth, and Ho*
of the Day?

1. The Globe being rectified to the Latitude of *London*, 51
31m. N. alſo the Hour Index placed at Noon with 18d. 30m. i
♌, the Sun's Place for the 11th of *Auguſt*, brought under the Me
ridian, and the Quadrant of Altitude ſcrewed in the Zenith;

2. Then move the Globe and Quadrant of Altitude, 'till yo
bring 11d. 30m. on the latter to lie juſt over 18d. 30m. of ♌
in the Ecliptic, and there ſtay them both.

3. Then doth the Quadrant of Altitude, lie right againſt 80d
in the Horizon, from the North towards the Eaſt, and the Sun'
Azimuth, is near about E. by N.

4. And then the Hour Index points to 6 Hours nearly, that is
Six of the Clock in the Morning.

Problen

oblem 17. *The Latitude of a Place, the Day of the Month, and Sun's Azimuth given; to find his Altitude, and Hour of the Day?*

The Rule. 1. Rectify the Globe, Hour Index, and Quadrant of ltitude, as before.

2. Turn the Quadrant of Altitude, to the given Azimuth, in e Horizon, and there ſtay it.

3. Then bring the Sun's Place in the Ecliptic (keeping the uadrant of Altitude fixed) to the graduated Edge thereof, (which alſo before ſet to his given Azimuth;) and ſtay the Globe there.

4. Then doth the Ecliptic cut the Quadrant in the required Al-ude, and the Index ſheweth the Hour of the Day deſired.

Example. *At* Barbadoes *the 17th of* October, *the Sun's Azimuth the Afternoon, being* S W. half W. *or* 50d. 30m. South Weſter-; *I demand his Altitude, and Hour of the Day?*

Anſw. Obſerving the aforeſaid Directions, and turning the obe, and Quadrant of Altitude towards the Weſt, you will find Sun's Altitude to be 55d. 45m. and the Hour of the Day 44m. er 1 in the Afternoon.

oblem 18. *The Latitude of a Place, the Sun's Altitude and Azi-uth given; to find his Place in the Ecliptic, and Hour of the Day?*

The Rule. 1. Rectify the Globe to the Latitude, and ſcrew the adrant of Altitude to the Zenith.

2. Turn the graduated Edge of the Quadrant of Altitude to the en Azimuth, in the Horizon, and there ſtay it.

3. Turn the Body of the Globe (without ſtirring the Quadrant t of its Place) 'till the Ecliptic cut the Quadrant in the given Al-de; which will then cut the Ecliptic in the Sun's Place required.

4. Then turn the Sun's Place to the Braſs Meridian, and rectify Hour Index to 12.

5. Turn back the Sun's Place to the graduated Edge of the adrant (it being in the ſame Place, that is, at the given Azi-th as before) and then the Index will ſhew the Hour of the Day uired.

Note; In turning the Globe according to the third Step in Rule, the given Altitude in the Quadrant will cut the

Ecliptic in two ſeveral Signs, and yet the Hour of the Day fou by the fourth Step, will be the ſame; ſo that unleſs the Mon be given, the Sun's Place cannot be determined.

Example. *At* London, *the* 19*th of* June, *the Sun's Altitu being* 49d. 40m. *and his Azimuth* S. 60d. 15m. Eaſterly: *I dema his Place in the Ecliptic, and the Hour of the Day?*

Anſwer. The Sun's Place is nearly 28d. in ♊, and it is 29 after 9 in the Morning, the 19th of *June* at *London:* Alſo t Sun's Altitude and Azimuth being the ſame, his place may about 2d. in ♋, and yet the Hour the ſame, on the 23d. *June*, by the Method uſed in the 4th and 5th of laſt Directions.

Note; All theſe Problems may be wrought, having the Sur Declination given, inſtead of the Day of the Month, as may ſeen in the next *Problem.*

Problem 19. *The Latitude of a Place, the Declination and Al tude of the Sun given; to find his Azimuth, and Hour of the Day*

The Rule. 1. Rectify the Globe to the given Latitude, and t Quadrant to the Zenith as before.

2. Bring the Equinoctial Colure to the Braſs Meridian, a then ſet the Hour Index to the upper 12; which is rectifyi the Globe when the Declination is given.

3. Move both Globe, and Quadrant of Altitude, 'till the giv Altitude on the latter meet with the given Declination in t Equinoctial Colure on the former, and there ſtay them both.

4. Then doth the Quadrant cut the Horizon in the Sun Azimuth, and the Index ſheweth the Hour of the Day require Alſo, at the ſame Time, the Braſs Meridian cuts the Equinocti in ſo many Degrees (counting from the Colure, allowing 15 to an Hour) as the required Hour of the Day is, either before after Noon.

Example. *At* London, *the Sun's Declination being* 15d. 15m North, *and his Altitude* 11d. 30m. *in the Morning: I demand h Azimuth and Hour of the Day?*

Anſwer. The Sun is E. by N. and the Hour near about Si o'Clock, or 90d. of the Equinoctial are intercepted between th Equinoctial Colure and Braſs Meridian; which makes 6 Hou from Noon, at which Time the Sun is Weſt in the Afternoon.

In like manner may any of the preceding Problems be wrough obſerving the following general Directions.

1. Count the Latitude on the Braſs Meridian.

2. The Declination on the Colure from the Equinoctial, eithe Northward or Southward, according to its Name.

3. The Altitude on the Quadrant of Altitude.

. The Azimuth on the Horizon, from the Braſs Meridian to
Quadrant of Altitude.
. And the Hour (from Noon in Degrees) on the Equinoctial,
n the Equinoctial Colure to the Braſs Meridian.
Then having any Three of theſe Five given, the other Two
y be found, which I leave for the Learner's Exerciſe.
Vote; All the foregoing Problems, may be wrought on either
bc; but the following only on the *Cæleſtial Globe.*

b. 20. *To find the Declination and Right Aſcenſion of any Fixed Star.*

he Rule. 1. Bring the given Star to the Braſs Meridian, and
e ſtay the Globe.
. Then the Center of the Star cuts the Braſs Meridian in it's
lination, counted from the Equinoctial either Northward, or
thward,
. And the Braſs Meridian cuts the Equinoctial in it's Right
enſion, counted from the Beginning of *Aries,* according to
Succeſſion of the Signs.

xample. *I demand the Right Aſcenſion and Declination of* Aldebaran, *or* Oculus Tauri, *the Bull's Eye.*
nſw. According to the Directions above, you will find its
nt Aſcenſion 65d. 25m. and it's Declination near 15d. 58m.
th.

roblem 21. *To find the Latitude, and Longitude of a Star.*
he Rule. 1. Bring the Solſtitial Colure to the Braſs Meridian,
the Pole of the Ecliptic on the Globe may be juſt under 23d.
n. on the ſaid Meridian, and there fix the Body of the Globe.
. Screw the Quadrant of Altitude juſt over the Pole of the
ptic.
. Bring the graduated Edge of the ſaid Quadrant to the
ter of the Star, and there ſtay it.
. Then the Star cuts the Quadrant in its Latitude, and the
drant cuts the Ecliptic in its Longitude.

mple. *I demand the Latitude, and Longitude of* Arcturus, *a Star of the firſt Magnitude in the Conſtellation* Bootes?
nſwer. This Star's Latitude is 30d. 57m. N. nearly, and its
gitude 20d. 24m. in *Libra*, or 200d. 24m. from the begin-
; of *Aries*; and ſo for any other, as in the following Table.

Stars Names.	Magn.	Longitude. D. M.	Latitude	Right Aſcen. D. M.	Declination D. M.
Pole Star, or North-Star	2	♊ 26.05	66.30 N	10.45	87.58 N
Laſt in Eridanus Alcarnar	1	♓ 10.55	59.55 S	21.15	58.55 S
Whale's Jaw, Cetus	2	♉ 10.30	12.37 S	42.02	03.04 N
Bull's Eye, Aldebaran	1	♊ 5.58	5.30 S	65.25	15.58 N
Capella, on Auriga's left Shoulder	1	♊ 18.02	22.52 N	74.36	45.43 N
Orion's left Foot, Rigel	1	♊ 13.00	31.10 S	75.39	08.30 S
Orion's right Shoulder	1	♊ 24.55	16.05 S	85.27	07.20 N
Great Dog, Syrius	1	♋ 10.19	39.32 S	98.34	16.23 S
Little Dog, Procyon	1	♋ 22.00	15.58 S	111.33	05.51 N
Hydra's Heart, Alphard	1	♌ 23.28	22.24 S	138.51	07.36 N
Lyon's Heart, Regulus	1	♌ 26.01	00.37 N	148.47	13.10 N
Foot of the Croſiers	2	♍ 08.08	52.45 S	183.35	61.31 S
Virgin's Spike	1	♎ 20.01	02.02 S	198.03	09.51 S
Arcturus in Bootes	1	♎ 20.24	30.57 N	211.06	20.30 N
Bright Star of the Harp, Lyra	1	♑ 11.27	61.46 N	277.08	38.34 N
South Fiſh, Fomelhaut	1	♒ 29.59	21.05 S	340,58	30.56 S

Problem 22. *To find the Riſing, Setting, and Culmination of Star, at any Time, in any Latitude.*

The Rule. 1. Rectify the Globe and Hour Index, as in Pr blem 10.

2. Bring the Star (whoſe Riſing you would know) to the Ea Side of the Horizon, and then the Index will point to the Tim of its Riſing; alſo the Degree of the Horizon againſt the Sta is its Amplitude at Riſing.

3. Bring the Star to the Braſs Meridian, and the Index wi ſhew the Time of its Culminating, or coming to the Meridia Alſo the Degree on the Braſs Meridian, contained from th Horizon to the Star, is its Meridian Altitude.

4. Bring the Star to the Weſt Side of the Horizon, and th the Index will ſhew the Time of its Setting; Alſo againſt th Star, (on the Horizon) is its Amplitude at Setting, which ever the ſame Quantity as at Riſing.

Th

This is ſo eaſy to perform, and ſo often done in the Problems
ncerning the Sun, it needs no Example.

oblem 23. *To know at any Time what Stars are above the Horizon, either Riſing towards the Meridian, or falling from it, towards their Setting; as alſo what is their Latitude and Azimuth?*

The Rule. 1. Rectify the Globe, Hour Index, and Quadrant
Altitude, as before, in Problem 10.
2. Turn the Globe till the Hour Index points to the given
me of the Day or Night; and there ſtay the Globe.
3. Then obſerve what Stars are even with the Eaſt Side of the
rizon, thoſe are then riſing; and all thoſe that are between
Horizon and Eaſt Side of the Meridian, are riſen above the
rizon, and aſcending towards the Meridian.
4. All thoſe Stars near the Braſs Meridian, are then near the
eridian of that Place; and thoſe at the Braſs Meridian, are then
the Meridian of that Place.
5. If the Quadrant of Altitude be put to any Star, it will ſhew
Altitude at that Time and Place, and in the Horizon, the
adrant ſhews its Azimuth.
6. All thoſe Stars on the Weſt Side of the Meridian are de-
nding from it, towards their Setting; thoſe near the Horizon
Setting, and thoſe below the Horizon are Set.
n a Word, let the Globe (by the help of a Magnetic Needle,
Compaſs, or otherwiſe, Variation allowed) be ſet ſo, as the
rth Pole thereof may point to the true North in the Heavens,
the South Point to the South; then imagine your Eye placed
hin the Globe at it's Center, and that the Globe was tranſpa-
t; or ſuppoſing a ſmall round Hole through the Center of any
r, now your Sight paſſing thro' it, will direct to the Star in the
ivens, correſpondent to that on the Outſide of the Globe.
This being mathematically conſidered, will make the Uſe of
Globes eaſy; and very much conduce to the knowledge of
Stars; a Thing not a little neceſſary in Navigation, but too
ch neglected by moſt Mariners.

blem 24. *To find the Hour of the Night by the Altitude of a known Star.*

he Rule. 1. Rectify the Globe, Hour Index, and Quadrant
Altitude, as before, in Problem 10.
. Turn the Globe and Quadrant of Altitude till you bring the
against its given Altitude in the Quadrant, and there ſtay them

3. Then will the Index ſhew the Hour required; and th Quadrant will cut the Horizon in the Star's Azimuth.

Note; If the Star you obſerve be on the Eaſt Side of the Me ridian, then turn the Quadrant of Altitude on the Eaſt Side of th Braſs Meridian of the Globe; And if on the Weſt Side, turn th Quadrant alſo on the Weſt Side.

Example. *At* London, December the 23*d*, *the Altitude of* R gulus, *or the* Lyon's Heart, *being* 25d. 30m. *Oriental, or the Eaſt Side of the Meridian: I demand the Hour of the Nigh*

Anſw. According to the aforeſaid Rule, the Hour is near 30 after 10 at Night, and the Star's Azimuth 78d. 30m. Sou Eaſterly, or Eaſt by South neareſt.

So much for the Uſe of the Globes, which is gone far beyo its firſt deſigned Limit, occaſioned by a conſtant Reſolution be as explicit, and conciſe as poſſible.

And, by the way, let me adviſe thoſe who have not Conve ency for, nor Ability to purchaſe Globes, and yet would kn the Stars, that they may attain it with a pair of Hemiſpher wherein are all the Conſtellations, and each Star according to Longitude and Latitude placed on them; ſuch are made of n 20 Inches in Diameter, to fold in a Book, like a Sea-Cha in four Leaves: They are projected on the Plane of the Ecli tic, or, as ſome ſay, on the Poles of the Ecliptic: So that one Hemiſphere (which is one Leaf) you have all the Conſt lations on the North Side of the Ecliptic, and in another all t Southern.

Each *Pole of the Ecliptic*, is the Center of each Hemiſphe and the Margin going round them is the Ecliptic, being divid into 12 Signs, and each Sign into 30 Degrees; each Deg being ſubdivided into Halves and Quarters; And Lines dra from the Center (or Pole of the Ecliptic) to the beginning each Sign.

On one of thoſe Lines are placed the Degrees of Latitude, a numbered from the Ecliptic with 10, 20, &c. to 90, at the P and Center of it.

By theſe Hemiſpheres any of the former Problems (wrought the *Cœleſtial Globe*) may be ſolv'd: As for Inſtance;

To find the Longitude, and Latitude of a Star.

The Rule. 1. Stretch out the Silk String (faſtened in Center for that Purpoſe) over the Center of the given Star, a it ſheweth, or cutteth the Star's Longitude in the Ecliptic.

2. With a pair of Compaſſes, take the Diſtance from the Cen- er of the Star to the Center of the Hemiſphere; lay that Diſtance n the Scale of Latitude from the Center of the Hemiſphere, and will ſhew the Latitude required, reckoned from the Ecliptic.

Example. *The Foot of the* Croſiers, *a Star of the ſecond Mag- itude in the Southern Hemiſphere, between* Robur Carolinum, *and* entaurus: *I demand it's Latitude and Longitude?*

1. Laying the ſaid Silk String over the Star's Center, it cuts he Ecliptic in *Virgo*, 8d. 8m. the Star's Longitude.

2. Take the Star's Diſtance from the Center of the Hemi- here, meaſure it on the Solſtitial Colure, from the ſaid Center, nd it reaches to 52d. 45m. the Star's Latitude South.

There are drawn in theſe Hemiſpheres, the Equinoctial, Tro- ics, Polar Circles, and Poles of the World; all which are diſ- nguiſhed by their Names ſet to them: More Circles may be rawn, and are of Uſe in ſerving other Problems; which ſhall be ewed after the Problems in Aſtronomy.

CHAPTER VII.

Spheric Trigonometry, *applied in* Problems *of* Geography.

BEfore I treat of Great Circle Sailing, 'twill not be amiſs to ſay ſomething concerning Geography; and for a more diſtinct nowledge thereof, take theſe following Definitions and Prob- ms. The Definitions are much the ſame as before, in Chapter . of *Mercator's Sailing*, in page 82.

Section I. *Geographic Definitions. Plate* 5. *Fig.* 1.

. THE *Earth* (on which we dwell) together with the *Water*, make one round Body or Globe, which is the Subject of *eography.*

2. The *Poles of the Earth*, are two imaginary Points, directly ppoſite, upon the Surface of it; that in the North, called the orth Pole; and that in the South, called the South Pole; As and I. *Plate* 5. *Fig.* 1.

3. The *Equator*, or Line under the Equinoctial, is a Line rawn round the Globe, and lieth in the middle between both oles, cutting all Meridians at Right-Angles, and is a Great ircle, from which Latitude taketh its Beginning, and in which ongitude is reckon'd, as ÆAQ. *Plate* 5. *Fig.* 1.

4. *Meridians*, are Great Circles drawn thro' both Poles cutting he Equator at Right-Angles, as PQI, PAI, and PMI, anſwer- ble to them, are the North and South Lines drawn in any Chart

5. Parallels of Latitude are leſs Circles drawn parallel to the Equator, through every Degree and Minute of the Meridian, between the Equator and each Pole, as *a l t* and Z* *l t*, and are repreſented in any Chart, by the Eaſt and Weſt Lines therein.

6. Latitude is an Arc of a Meridian, contained between any Parallel and the Equator; from whence it is counted both Ways to each Pole, where it ends in 90 Degrees, which is the greateſt Latitude.

7. North Latitude, is on that Side of the Equator towards the North Pole, and South Latitude towards the South Pole.

8. Difference of Latitude, is an Arc of a Meridian, and the neareſt Diſtance between any two Parallels, and ſheweth how far any Place is to the Northward or Southward of another Place, and never exceedeth 180 Degrees.

9. Longitude, is reckoned in the Equator, round which, increaſing to the Eaſtward, 'tis counted (by ſome) till it end (where it firſt began) in 360 Degrees, which is the greateſt Longitude: Or, according to Mr. *Wakely*, in his *Mariner's Compaſs Rectified*, 'tis counted from the Meridian of *London*, increaſing on both Sides of it, Eaſtward and Weſtward, till it terminates in 180 Degrees, at the oppoſite Meridian.

10. Longitude of a Place, is an Arc of the Equator contained between the Meridian of that Place, and the firſt Meridian where Longitude taketh its beginning, and counted (by the old Way) to the Eaſtward of the firſt Meridian, (but by the new Way in the *Mariner's Compaſs Rectified*, and likewiſe in the *Mariner's Calendar*) 'tis counted both Eaſtward and Weſtward from the Meridian of *London*, which in both theſe Tables is the Meridian, whence Longitude taketh it's Beginning.

11. Difference of Longitude is an Arc of the Equator, contained between the Meridians of any two Places, and never exceedeth 180 Degrees.

12. The Diſtance of any two Places, is an Arc of a Great Circle, paſſing thro' them, and never exceedeth 180 Degrees.

13. The Angle of Poſition, or the Angle of Situation of Places, is an Angle that the Arc of a great Circle paſſing over two Places, makes with the Meridian of one of them, and is not the Courſe leading from one to the other.

In finding the Diſtance of Places, there are three Caſes: As (1.) when they differ only in Latitude; (2.) when they differ only Longitude; (3.) when the two Places differ both in Latitude and Longitude; all which are performed by the following Problems.

Section

Section II. *Geographic Problems.*

aſe 1. *Two Places differing only in Latitude, given; to find their Diſtance.*

ote 1. TWO Places under one Meridian, or bearing North and South from each other, or in one Longitude, e ſaid to differ only in Latitude.

2. Two Places differing only in Latitude, the Difference of atitude is the Diſtance required; In which there are two Va- ties.

Variety 1. Problem 1. *Two Places both on the ſame Side of the quator; that is, both in North, or both in South Latitude; to d their Diſtance.*

The Rule. Subtract the leſs Latitude from the greater, the mainder (reduced into Leagues or Miles) is the Diſtance re- ired.

Variety 2. Problem 2. *If one Place be on one Side of the Equa- , the other on the other Side; that is, one in North Latitude, d the other in South Latitude; to find their Diſtance?*

The Rule. Add the two given Latitudes together, the Sum educed into Leagues or Miles) is the Diſtance required.

Theſe are ſo eaſy, 'tis needleſs to give Examples, being the ne you had in Chapter 3. Section 3. General Rule 2. in *Plane- iling*, in page 58.

ſe 2. *Two Places differing only in Longitude given; to find their Diſtance.*

Note; Two Places differing only in Longitude, lie Eaſt and eſt from each other, and are either in the Equator, or elſe in e Parallel of Latitude.

In this *Caſe* are two Varieties.

ſe 2. Variety 1. Problem 3. *Two Places in the Equator, their Longitudes being given; to find their Diſtance?*

The Rule. 1. According to the old Way of counting the ongitude, ſubtract the leſs Longitude from the greater, the Re- inder (if leſs than 180 Degrees) is the Diſtance required; t when 'tis more, ſubtract it from 360 Degrees, and this laſt mainder is the Diſtance.

2. According to the new Way of counting the Longitude, in *Mariner's Compaſs Rectified*, the Rule is thus;

If both Longitudes are Eaſt, or both Weſt, ſubtract the leſs m the greater, the Remainder is their Diſtance: But when e Place is in Eaſt, and the other in Weſt Longitude, add em, and the Sum (if it exceed not 180 Degrees) is the Diſ-ſtance, and when it doth exceed 180 Degrees, ſubtract it fro 360 Degrees, the Remainder is the Diſtance required, which the ſame as in Chapter 4. Section 2. Problem 3. page 89. *Mercator's Sailing.*

Caſe 2. Variety 2. Problem 4. *Two Places in one Parallel, both in one Latitude, their Longitudes given, to find the Diſtance.*

Example. *I demand the Diſtance between the* Lizard, *a* Pengwin Iſland *in* Newfoundland ?

		d.	m.		d.	m.	
Lizard	Latit.	50	00 N.	Longit.	5	14	W.
Pengwin Iſland					52	50	W.
Subtract from		90	00	Diff. Long.	47	36	
Rem. is the Comp. Lat.		40	00				

Theſe Places are both ſuppoſed in the Latitude of 50d. 00 North, whoſe Complement is 40d. 00m.

To delineate this Problem Stereographically on the Plane the Meridian of the *Lizard.* *Plate* 5. *Fig.* 1.

1. Deſcribe the Circle ÆPQI, with a Chord of 60 de or Half-tangent of 90 Degrees, and quarter it, with the tw Diameters or Right Circles PAI, and ÆAQ: Then is P th North Pole, I the South Pole, and ÆAQ the Equator.

2. By Problem 2. Caſe 2. page 112. of Spheric Geometr make the Angle ÆPN equal to 47d. 36m. (the Difference Longitude) by drawing the Oblique Circle P ⊙ N I, with th Secant thereof.

3. Make PZ equal to 40d. 00m. (the Complement of the g ven Latitude) by Prob. 6. Caſe 1. page 116. of Spheric Geometr

4. Through Z drawn the Parallel Circle Z ⊙ l t (by Proble 9. Caſe 2. in page 121. of Spheric Geometry) with the Tange of 40d. 00m. (the Complement of the given Latitude) to cut th Oblique Circle P ⊙ N I in ⊙: Then Z repreſent the *Lizar* and ⊙ *Pengwin Iſland*, both in one Parallel of Latitude.

5. Then thro' Z and ⊙, draw a great Circle, as is the Ob lique Circle Z⊙C, and it's done; for Z⊙ on the Oblique Circ is the Diſtance required, which is meaſured by Problem 7. Ca 3. in page 118. of Spheric Geometry.

To find their Diſtance by Trigonometry, 'tis to be noted; That in the Oblique Spheric Triangle ZP⊙. *Plate* 5 *Fig.*

1. The Side ZP equal to P ⊙ is the *Comp. of the Lat.* 40d. 00
2. The Angle ZP⊙ the *Difference of Longitude* 47d. 36m.

3. The Side Z⊙ the Diſtance of the two Places; which to nd, let fall the Perpendicular PB (by drawing an Oblique Cire with the Secant of 23d. 48m. half the (given) Difference of ongitude to cut the Oblique Circle Z ⊙ (in B) and it divides e Oblique-Spheric-Triangle into two equal Rectangle-Spheric riangles PBZ and PB⊙, in each, the Hypotenuſe and one ngle is given.

1. The Angle ZPB equal to BP⊙, is half the Difference of ongitude, 23d. 48m.

2. The Leg ZB equal to B ⊙, is half the Diſtance required.

Therefore the Proportion by Chapter 5. Section 4. Problem 2. aſe 4. in page 136. of Rectangular Spheric Trigonometry, is us;

As Radius, is to the Sine Complement of the Latitude; ſo is e Sine of half the Difference of Longitude, to the Sine of half eir Diſtance required. But in ſhort thus,

s Radius : : S. *Hypot.* PZ : : S. Angle ZPB ·· S. *Leg.* ZB ½ the Diſt.

s S. 90d. : : S. 40d. 00m. : : S. 23d. 48m. ·· S. 15d. 02m.

Which being doubled, makes the Diſtance 30d. 04m. or 1804 linutes, which is the Diſtance between the *Lizard* and *Pengwin land*, in the Arc of a Creat Circle.

rob. 5. *To find how many Miles or Minutes of the Equator make a Degree of Longitude, in any Parallel of Latitude.*

The Rule or Proportion is,

As Radius, is to the Sine Complement of the Latitude;

So is 60 Miles or Minutes a Degree in the Equator, to the liles or Minutes of the Equator, which make a Degree of Lontude in the Parallel required.

Example. *How many Miles will anſwer to make a Degree of Longitude in the Latitude of* 51d. 31m.

s Radius ·· S.c. Lat. : : a deg. in the Equa. ·· a deg. in the Par.

s S. 90d. ·· S. 38d. 29m. : : 60 Minutes ·· Min. 37.34 Parts.

he Miles of the Equator that make a Degree of Longitude in e Latitude of 51d. 31m.

aſe 3. *Two Places differing both in Latitude and Longitude, their Latitudes and Longitudes being given to find their Diſtance.*

Note, In this Caſe are three Varieties.

Variety 1. Problem 6. *One Place in the Equator, and the her towards either of the Poles.*

Example. *Suppoſe the* Lizard, *and the Entrance of the River* mazons, *their Latitudes and Longitudes being as followeth: I deand their Diſtance?*

Lizard

		d. m.		d. m.
Lizard	Lat.	49.57	N. Long.	5.14. W.
Amaz. River		00.00		49.56 W.
Difference of Longitude				44.42

To delienate it Stereographically on the Plane of the Meridi of the *Lizard*. *Plate* 5. *Fig.* 1.

1. The Circle being deſcribed, and quarter'd as before, Problem 4. make ÆZ on the primitive Circle equal to 49 57m. the Latitude of the *Lizard*, by Problem 6. Caſe 1. in pa 116. of *Spheric Geometry.*

2. By the ſame Problem, Caſe 2. lay 44d. 42m. the give Difference of Longitude, on the Right Circle ÆAQ (which the Equator) that is, take the Half Tangent 44d. 42m. t contrary Way, and lay it from Æ to N.

3. Then through Z and N draw a Great Circle, as is t Oblique Circle ZNC, and 'tis done: For ZN (meaſu b Problem 7. Caſe 3. in page 118. of *Spheric Geometry*) is the D tance required.

But to find their Diſtance by Trigonometry; Obſerve,

2. That in the Rectangle Spheric Triangle ZÆN. *Plate* *Fig.* 1.

1. The Leg ZÆ, is the Latitude of the *Lizard*, 49d. 57m The Leg ÆN, the Difference of Longitude between them equal to 44d. 31m.

3. The Hypotenuſe ZN, their Diſtance required, to fin which (by Chapter 5. Section 4. Problem 5. Caſe 14. in pag 140. of *Rectangular Spheric Trigonometry*) the Proportion is thus

As Radius, is to the Sine Comp. of the *Lizard*'s Latitude;

So is the Sine Complement of their Difference of Longitude to the Sine Complement of their Diſtance required: But i ſhort thus:

Radius ·· S.c. Leg ZÆ : : S.c. Leg ÆN ·· S. c. Hyp. ZN Diſ
S. 90d. ·· S. 40d. 03m. : : S. 45d. 18m. ·· S. 27d. 13m. whoſ
Complement is 62d. 47m. equal to 3767 Minutes, is the Diſ tance between the *Lizard* and River *Amazons.*

Caſe 3. Variety 2. Problem 7. *Two Places lying towards one o the Poles; that is, both in North Latitude, or both in Sout Latitude, their Latitudes and Longitudes being given; to fin their Diſtance.*

Example. I demand the Diſtance between the *Lizard* and th Iſland *Barbadoes?* *Lizar*

izard	Lat.	49.57	N. Long.	5.14 W.
. Barbadoes		12.58		58.50 W.
)ifference of Longitude				53.36

To delineate this Stereographically, on the Plane of the Me-
ian of the *Lizard.*

1. Having deſcribed the Primitive Circle, and quarter'd it as
ore, make the Angle ÆPm, (by Problem 2. Caſe 2. in
e 112. of *Spheric Geometry)* equal to 53d. 36m. the given
ference of Longitude, by drawing the Oblique Circle PmI,
h the Secant thereof.

. On the Primitive Circle (by Prob 6 Caſe 1. in page 116.
pheric Geometry) make PZ equal to 40d. 03m. the Comple-
nt of the *Lizard*'s Latitude, by laying the Chord thereof from
 Z.

. Draw the Parallel Circle *a*L*lt* (by Prob. 9. Caſe 2. in
e 121. of *Spheric Geometry)* at 12d. 58m. (*Barbadoes* Latitude)
ance from the Right Circle ÆAQ, the Equator, to cut the
lique Circle PmI in L.

. Then thro' Z and L, draw a Great Circle, as the Oblique
cle ZLMC, and it's done; for ZL (meaſured by Problem 7.
e 3. in page 113. of Spheric Geometry) is the Diſtance re-
ed.

ut by Spheric Trigonometry, to find their Diſtance, it is to
noted,

hat in the Oblique Spheric Triangle ZPL. *Plate* 5. *Fig* 1.
. The Side PZ is the Comp. of the *Lizard*, Lat. 40d. 03m.
. The Side PL is the Comp. of *Barbadoes* Lat. 77d. 02m.
. The Angle ZPL their Difference of Longitude 53d. 36m.
. The Side ZL their Diſtance required.

o find which (by Chap. 5. Section 5. Problem 9. Caſe 8.
age 145. of Spheric Trigonometry Oblique) The Rule is,
irſt, As Radius, is to the Sine Complement of the Difference
ongitude; ſo is the Tangent Complement of the greater
itude, To the Tangent of a Fourth Arc.

Vhich being ſubtracted from the Complement of the leſs La-
de, when the Difference of Longitude is leſs than 90 De-
s, but when more than 90 Degrees from its Supplement to
 Degrees, the Remainder is the Reſidual Arc. Then,
econdly, As the Sine Complement of the Fourth Arc afore-
d, is to the Sine Complement of the Reſidual Arc; ſo is
Sine of the greater Latitude, to the Sine Complement of
the

the Diſtance required: But in ſhort, as follows;
As Radius ·· S.c. Angle ZPL : : S.c. Side ZP ·· T. 4th Arc.
As S. 90d. ·· S. 36d. 24m. : : S. 40d. 03m. ·· T. 26d. 31
which being ſubtracted from the Side PL 77d. 02

Remainder is the Reſidual Arc ——————— 50d. 31
Then again ſay,
As S.c. 4th Arc ·· S.c. Reſid. Arc : : S.c. Side ZP ·· S.c. Side Z
As S. 63d. 29m. ·· S. 39d. 29m. : : S. 49d. 57m. ·· S. 32d. 57
Whoſe Complement 57d. 03m. or 3423 Minutes, is the
ſtance from the *Lizard* to Iſland *Barbadoes* in the Arc of a Gr
Circle.

Caſe 3. Variety 3. Problem 8. *Two Places, one in North La*
tude, the other in South Latitude; their Latitudes and Longitu
given; to find their Diſtance.
Example. *I demand the Diſtance from Cape* Cod *in* New En
land, *to Cape* Bona Eſperance, *or Cape of* Good Hope
Africa?

		d. m.		d. m.
Cape Cod	Lat.	42 12 N.	Longit.	68 55 W.
C. Bona Eſp.		34 07 S.		19 35 E.

Difference of Longitude is ——————— 88 30

To delineate it Stereographically on the Plane of the Meridi
of *Cape Cod. Plate* 5. *Fig.* 1.

1. The Primitive Circle being deſcribed, and quarter'd as b
fore directed, (make by Problem 2. Caſe 2. in page 112 of *Sp*
ric Geometry) the Angle QPM equal to 88d. 30m. the giv
Difference of Longitude, by drawing the Oblique Circle P
with the Secant thereof: But the Secant is ſo large that 'tis
eaſy to do; therefore in ſuch Caſes, lay it on the Right Cir
ÆNAMQ, the Equator (by Problem 6. Caſe 2. in page 116
Spheric Geometry) from Q to M, that is, from the Scale of Ha
tangents the contrary way; and laying a Bow ſcrew'd up to t
three Points, P, M, and I, draw the Oblique Circle by it.

2. On the Primitive Circle, (by Problem 6. Caſe 1. in pa
116.) make PZ equal to 47d. 48m. the Complement of *C*
Cod's Latitude.

3. Draw the Parallel Circle *a D l t* (by Problem 9. Caſe 2.
page 121.) at 34d. 07m. *Cape Bona Eſperance* Lat. (or Diſtan
from the Right Circle ÆAQ the Equator) to cut the Obliq
Circle PMI, in D, repreſenting *Cape Bona Eſperance.*

4. Thro' Z and D, draw a Great Circle, as the Oblique Cir
ZDC, and 'tis done: For ZD (meaſured by Problem 7. Caſe
in page 118. of *Spheric Geometry)* is the Diſtance required.

Spheric Trigonometry, to find their Diſt. it's to be conſider'd
That in the Oblique Spheric Triangle ZPD. *Plate* 5. *Fig.* 1.

1. The Side PZ is the Comp. of *Cape Cod*'s Latit. 47^{d}. 48m.
2. The Side PD the Diſtance of *Cape Bona Eſperance* from the
rth Pole, or its Latitude added to 90d. that is 124^{d}. 07m.
3. The Angle DPZ their Differ. of Longitude 88d. 30m.
4. The Side ZD their Diſtance required, which is thus found,
Chapter 5. Section 5. Problem 9. Caſe 8. in page 145, of
heric Trigonometry Oblique, the Proportions are theſe,

Firſt; As Radius, is to the Sine Complement of their Diffe-
ce of Longitude; ſo is the Tang. Complement of one of the
en Latitudes, to the Tangent of a 4th Arc; And then,
If the Difference of Longitude be leſs than 90d. ſubtract the
Arc out of the other Latitude, added to 90d. but if the
ff. Long. be more than 90d. from the Supplement thereof to
0d. the Remainder is the Reſidual Arc; And then,

Secondly; As the Sine Complement of the Fourth Arc, is to the
ie Complement of the Reſidual Arc; ſo is the Sine of the Lati-
le firſt taken, to the Sine Complement of the Diſtance re-
ired: But in Short thus;

Radius ·· S.c. Ang. DPZ : : T. Side PZ .. T. 4th Arc.
S. 90d. ·· S. 01d. 30m. : : T.47^{d}.48m. ·· T. 1d. 39m. which
being ſubtracted from the Side PD ——— 124^{d}. 07m.

The Remainder is the Reſidual Arc —— 122d. 28m.

Then again ſay,

:. 4th Arc ·· S.c. Reſidual Arc : : S.c. Side PZ ·· S. c. Side ZD.
88d. 21m ·· S. 32d. 28m. : : S. 42d. 12m. ·· S. 21d. 09m.
hich added to ——————————— 90d. 00m.

he Sum is the Side ZD their Diſtance ——— 111d. 09m.
Or 6669 Minutes is the Diſtance from Cape *Cod* to Cape *Bona
ſperance*, in the Arc of a Great Circle.

CHAPTER VIII.

f the third Part of Navigation, or the Doctrine of Spheric Trigonometry applied in Great-Circle Sailing.

REAT-Circle Sailing, as it's the moſt acurate ſo it's the
moſt difficult, and hardly poſſible for a Ship exactly to ſail
by;

by; yet it may be of good Advantage to keep conveniently n it, eſpecially in a parallel (or Eaſt and Weſt) Courſe.

2. *Great Circle Sailing*, is Sailing by, or upon the Arc of Great Circle, paſſing through the two Places.

3. In Great Circle Sailing are but three Caſes, *viz.*

(1.) When two Places differ only in Latitude.

(2.) When they differ only in Longitude; and,

(3.) When they differ both in Latitude and Longitude.

Caſe 1. *Two Places differing only in Latitude, the Latitu given, to find their Diſtance.*

1. This is the ſame with Chapter 7. Section 2. Problem 1 a 2. in page 183 of Geography, to which I refer the Reader f finding their Diſtance, and ſo paſs to

Caſe 2. *Two Places differing only in Longitude, the Latitude a Longitudes being given; to find their Diſtance in the Arc of Great Circle, and all that is requiſite in* Great Circle Sailing.

1. This is the ſame with Chapter 7. Section 2. Problem and 4. in pages 183 and 184, of Geography, to find their D ſtance.

2. Theſe Places are either in the Equator, or in one Parall and lie Eaſt and Weſt from each other; if under the Equato the Difference of Longitude is their Diſtance, that being a gre Circle, but if in one Parallel, the contained Arc of that Parall is not the neareſt Diſtance, that being a leſs or ſmall Circle.

3. The Diſtance in the Parallel hath been ſhewed in Chapt 4. Section 3. Problem 10. of *Mercator's Sailing*, in page 10 and their Diſtance in the Arc of a great Circle is found b Chapter 7. Section 2. Problem 4. in page 184 of Geograph But the Angles of Poſition made by the Great Circle, and i Latitude and Longitude at any aſſigned Point in the Arc, tog ther with the Courſe, and Diſtance from Point to Point, ſo aſſign in it, is the Work we now proceed upon.

Caſe 2. Problem 1. *Suppoſe the* Lizard, *and* Pengwin Iſlan *both in the Latitude of* 50d. 00m. North *nearly, whoſe Diff rence of Longitude is* 47d. 36m. (as before in Problem 4. i page 184 of *Geography) I demand the Angle of Poſition? T Great Circle's Diſtance between them? The Latitude of the A at every 5 Degrees Difference of Longitude? And the Courſe, an Diſtance from Point to Point according to* Mercator.

Th

This Problem is delineated by the Directions in Problem 4. of ography, in page 184. And obſerve that,

n the Oblique Spheric Triangle APC. *Plate* 5. *Fig* 2.

1. A repreſents the *Lizard.*

2. C *Pengwin* Iſland.

3. The Side PA equal to PC, the Complement of the Latitude each Place 40 Degrees.

4. The Angle APC, the Difference of Longitude 47d. 36m.

5. The Angle CAP equal to ACP, the Angle of Poſition at h Place.

6. The Side AC, the Great Circle's diſtance between them.

Firſt, For the Angle CAP equal to ACP, the Angles of Poſi-n at the two Places.

Draw the Perpendicular PB, (as was taught in Problem 4. of ography, in page 185.) which divideth the Oblique Triangle C, into two equal Rectangular Spheric Triangles ABP, and P, in each, the Hypotenuſe and one Angle are given. That is,

1. The Hypotenuſe PA equal to PC, the Complement of their itude 40 Degrees.

2. The Angle BPA, equal to BPC, half their Difference of ngitude 23d. 48m.

3. The Angle BAP, equal to BCP, the Angle of Poſition at h Place.

4. The Leg AB, equal to BC, half the Great Circle's Diſtance.

5. The Leg BP, the Complement of the Arc's greateſt Lati-e.

And by Chapter 5. Section 4. Problem 2. Caſe 6. of Spheric gonometry Rectangular, in page 137. the Proportion is thus;

As Radius is to the Sine of the Latitude; ſo is the Tangent of f the Difference of Longitude, to the Tangent Complement of Angle of Poſition at each Place. That is,

As Radius ·· S.c. Hyp. AP : : T.Angle APB ·· T.c. Angle BAP.
As 90d. ·· S. 50d. 00m. : : T. 23d. 48m. ·· T. 18d. 40m.
hich being ſubtracted from ———————— 90d. 00m.

mainder is the Angle of Poſition at each Place 71d. 20m.

econdly, The Leg AB, equal to BC, is found (by Problem 4. Geography, in page 185.) 15d. 02m. and therefore the Side is 30d. 04m. or 1804 Minutes, the Diſtance of the two ces in the Arc of a Great Circle.

hirdly, To find the Latitude by which the Arc ſhall paſs at ry 5 Degrees Difference of Longitude from A, repreſenting *Lizard*; theſe things following muſt be obſerved :

Firſt, Find the Leg BP, the Complement of the greateſt Latitude by which the Arc (of the great Circle) doth paſs; an that by Chapter 5. Section 4. Problem 2. Caſe 5. of Spheri Trigonometry Rectangular, in page 137. is thus;

As Radius, is to the Sine Complement of half the Differenc of Longitude.

So is the Tangent Complement of the given Latitude to th Tangent Complement of the Arc's greateſt Latitude; In ſhor thus;

As Radius ·· S.c. Angle BPA : : T. Hypot. PA ·· T.c. Leg BP
As S. 90d. ·· S. 66d. 12m. : : T.40d. 00m. ·· T. 37d. 31m
Which being ſubtracted from ———————— 90d. 00m

Remainder is the Arc's greateſt Latitude ———— 52d. 29m

Secondly, To find the Latitude by which the Arc of the Grea Circle paſſes (at every 5 Degrees of Longitude) from A, drav Meridians from P, as P d, P e, P f, *&c.* which may moſt eaſil be done Gnomonically, being then Right Lines, and that i thus, *viz.*

The Gnomonic Projection. *Plate* 5. *Fig.* 3.

1. Make the Angle APC equal to 47d. 36m. the Differenc of Longitude between the two given Places.

2. Make PA, and PC, each equal to the Tangent of 40d 00m. the Complemeut of the given Latitude.

3. Draw the Line AC, which repreſents the Arc of a Grea Circle between them.

4. Let fall the Perpendicular PB, which being meaſured on th Scale of Tangents, is 37d. 31m. the Complement of the Arc' greateſt Latitude.

5. Then draw Lines from P, each 5 degrees diſtance from as Pd, Pe, Pf, Pg, Ph, Pi, Pk, Pl, and Pm; which are Meridians, and each 5 Degrees of Longitude from A the *Lizard.*

6. Meaſure Pd, Pe, Pf, *&c.* on the Scale of Tangents, an they ſhew the Complements of the Latitudes of the Arc, at th reſpective Places, d, e, f, *&c.*

Theſe are found (by Spheric Trigonometry) after this manner; the ſeveral prick'd Lines Pd, Pe, *&c.* are ſo many Hypotenuſes, to as many Rectangular Spheric Triangles, whic have one common Leg BP, the Complement of the Arc's greateſt Latitude.

Now in each of theſe Rectangular Spheric Triangles, there given a Leg, and its adjacent Angle, to find the Hypotenuſe that is the Triangle d B P, there is given the Leg BP, and Ang BPd; to find the Hypotenuſe Pd, and ſo in all the reſt.

Ar

the ſeveral Angles B P d, B P e, &c. are found by a al Subtraction of 5 Degrees from the Angle B P A 23d. ıalf the Difference of Longitude, till the Remainder be n 5 Degrees, which being taken out of 5 Degrees, and aſt Remainder add 5 Degrees ſucceſſively 'till the Sum ext 23d. 48m. That is,

	d. m.
: Angle B P A	23.48
he Angle APD	5.00
is Ang. BPd	18.48
BPe	13.48
BPf	08.48
BPg	03.48
ıbtract from —	05.00
gle BPh equal	01.12

	d. m.
Then to the Angle BPh	=01.12
Add the Angle h P i	=05.00
Sum is the Angle BPi	06.12
BPk	11.12
BPl	16.12
BPm	21.12

Theſe Angles are called Vertical Angles, or Angles at the Pole.

ınd (by Chapter 5, Section 4, Problem 3, Caſe 9. of 'rigonometry Rectangular, in pages 137 and 138) the titudes of the Arc, which are by this Proportion ; ius, is to the Sine Complement of the Vertical Angle ; the Tangent or the Arc's greateſt Latitude, to the of the Arc's Latitude at the reſpective Places : Or ; ·· S.c.BPd, BPe, &c. : : T.c. Leg PB ·· T.c. Pd, Pe, &c.

·· S.71d. 12m. : : T.52. 29m. ·· T.50d. 57m. Lat. at. d.

	Latitude at	
76d. 22m.	51d. 40m.	e
81d. 12m.	52d. 09m.	f
86d. 12m.	52d. 25m.	g
88d. 48m.	52d. 29m.	h
83d. 48m.	52d. 19m.	i
78d. 48m.	51d. 57m.	k
73d. 48m.	51d. 21m.	l
68d. 48m.	50d. 32m.	m

ıt by the *Gunter*, the Extent from the Sine of 90 De- the Sine of 71d. 12m. will reach from the Tangent 29m. to Tangent 50d. 57m. And the Extent from d. to Sine 76d. 12m. will reach from Tangent 52d. o Tangent 51d. 40m. Alſo from Sine 90d. to Sine m. reacheth from Tangent 52d. 29m. to Tangent 52d. ıd ſo on for the reſt.

ɔy Logarithms it may be thus contracted ; becauſe the

Firſt

Firſt, Find the Leg BP, the Complement of the greate
ritude by which the Arc (of the great Circle) doth paſs
that by Chapter 5. Section 4. Problem 2. Caſe 5. of S
Trigonometry Rectangular, in page 137. is thus;

As Radius, is to the Sine Complement of half the Diff
of Longitude.

So is the Tangent Complement of the given Latitude
Tangent Complement of the Arc's greateſt Latitude;
thus;

As Radius ·· S.c. Angle BPA : : T. Hypot. PA ·· T.c.
As S. 90d. ·· S. 66d. 12m. : : T.40d. 00m. ·· T. 37
Which being ſubtracted from ———————— 90
Remainder is the Arc's greateſt Latitude ———— 52

Secondly, To find the Latitude by which the Arc of t
Circle paſſes (at every 5 Degrees of Longitude) from
Meridians from P, as Pd, Pe, Pf, *&c.* which may m
be done Gnomonically, being then Right Lines, an
thus, *viz.*

The Gnomonic Projection. *Plate* 5. *Fig.* 3.

1. Make the Angle APC equal to 47d. 36m. the D
of Longitude between the two given Places.

2. Make PA, and PC, each equal to the Tangent
00m. the Complemeut of the given Latitude.

3. Draw the Line AC, which repreſents the Arc of
Circle between them.

4. Let fall the Perpendicular PB, which being meaſur
Scale of Tangents, is 37d. 31m. the Complement of t
greateſt Latitude.

5. Then draw Lines from P, each 5 degrees diſtanc
as Pd, Pe, Pf, Pg, Ph, Pi, Pk, Pl, and Pm; which a
dians, and each 5 Degrees of Longitude from A the *Li*

6. Meaſure Pd, Pe, Pf, *&c.* on the Scale of Tange
they ſhew the Complements of the Latitudes of the Arc
reſpective Places, d, e, f, *&c.*

Theſe are found (by Spheric Trigonometry) after t
ner; the ſeveral prick'd Lines Pd, Pe, *&c.* are ſo m
potenuſes, to as many Rectangular Spheric Triangle
have one common Leg BP, the Complement of the Arc
eſt Latitude.

Now in each of theſe Rectangular Spheric Triangles,
given a Leg, and its adjacent Angle, to find the Hyp
that is the Triangle dBP, there is given the Leg BP, an
BPd; to find the Hypotenuſe Pd, and ſo in all the reſt.

And the ſeveral Angles B P d, B P e, *&c.* are found by a ntinual Subtraction of 5 Degrees from the Angle B P A 23d. m. half the Difference of Longitude, till the Remainder be s than 5 Degrees, which being taken out of 5 Degrees, and this laſt Remainder add 5 Degrees ſucceſſively 'till the Sum exed not 23d. 48m. That is,

d. m.
om the Angle B P A 23.48
btract the Angle APD 5.00

emain. is Ang. { BPd 18.48
BPe 13.48
BPf 08.48
BPg 03.48
hich ſubtract from — 05.00

the Angle BPh equal 01.12

d. m.
Then to the Angle BPh = 01.12
Add the Angle h P i = 05.00

Sum is the Angle { BPi 06.12
BPk 11.12
BPl 16.12
BPm 21.12

Theſe Angles are called Vertical Angles, or Angles at the Pole.

Then find (by Chapter 5, Section 4, Problem 3, Caſe 9. of heric Trigonometry Rectangular, in pages 137 and 138) the eral Latitudes of the Arc, which are by this Proportion;

As Radius, is to the Sine Complement of the Vertical Angle;
So is the Tangent or the Arc's greateſt Latitude, to the angent of the Arc's Latitude at the reſpective Places: Or
Radius ·· S.c. BPd, BPe, *&c.* : : T.c. Leg PB ·· T.c. Pd, Pe, *&c.*
S. 90d. ·· S. 71d. 12m. : : T. 52. 29m. ·· T. 50d. 57m. Lat. at. d.

76d. 22m.	51d. 40m.	Latitude at e
81d. 12m.	52d. 09m.	f
86d. 12m.	52d. 25m.	g
88d. 48m.	52d. 29m.	h
83d. 48m.	52d. 19m.	i
78d. 48m.	51d. 57m.	k
73d. 48m.	51d. 21m.	l
68d. 48m.	50d. 32m.	m

So that by the *Gunter*, the Extent from the Sine of 90 Deees, to the Sine of 71d. 12m. will reach from the Tangent 52d. 29m. to Tangent 50d. 57m. And the Extent from ne 90d. to Sine 76d. 12m. will reach from Tangent 52d. m. to Tangent 51d. 40m. Alſo from Sine 90d. to Sine d. 12m. reacheth from Tangent 52d. 29m. to Tangent 52d. m. and ſo on for the reſt.

But by Logarithms it may be thus contracted; becauſe the

Firſt and Third Terms in each Proportion are the ſame, and R dius being the Firſt, it follows;

That to the Tangent of the Arc's greateſt Latitude, add Sine Complement of each Vertical Angle, and from their S abate Radius, the Remainder is the Tangent of the Arc's La titude at each Place required: As for Example.

	d. m.				d. m.	
Ar. greateſt Lat.	52.29	Tang.	10.114758			
Comp. Ver tical Angles.	71.12	Sine	9.976189			Latitude of the Arc at
			10.090947	Tang.	50.57	
	76.12	Sine	9.987279			
			10.102037	Tang.	51.40	
	81.12	Sine	9.994857			
			10.109615	Tang.	52.09	
	86.12	Sine	9.999044			
			10.113802	Tang.	52.25	
	88.48	Sine	9.999905			
			10.114663	Tang.	52.29	
	83.48	Sine	9.997452			
			10.112210	Tang.	52.19	
	78.48	Sine	9.991649			
			10.106407	Tang.	51.57	
	73.48	Sine	9.982404			
			10.097162	Tang.	51.21	
	68.48	Sine	9.969567			
			10.084325	Tang.	50.32	

Thirdly, To find the ſeveral Courſes and Diſtances from Poi to Point, having now the Latitude and Longitude of them; th is done by Chapter 4, Section 3, Problem 2, of *Mercator's Sai ing*, in page 93.

As for Example. To find the Courſe and Diſtance from A to
There is given the Latitude of A 50d. 00m. North, and d. 50d. 57m. North, with their Difference of Longitud 5d. 300 Minutes Weſt.

Th

Their Meridional Difference of Latitude (by the Table of eridional Parts, in *Pages* 310 and 314) is 90 Minutes: erefore,

For the Courſe, the Proportion is;

As Merid. Diff. Lat. ·· Diff. Long. : : Radius ·· T. of the Courſe
As 90 Minutes ·· 300 Min. : : T. 45d. ·· T. 73d. 18m. N.
eſterly from A to d is the firſt Courſe.

For the Diſtance, the Proportion is,

s S. c. Courſe ·· Diff. Lat. : : Radius ·· Diſtance.
s S. 16d. 42m. ·· 57 Min. : : S. 90d. ·· 198.4 Min. from A
d.

fter the ſame manner find the Courſes and Diſtances from d , from e to f, *&c.* as follows.

For the Courſes, the Proportions are;

d.. m.
69 Min. ·· 300 Min. : : T. 45d. ·· T. 77.03 N.W. from d to e.
46 ——————————— 81.17 —— from e to f.
27 ——————————— 84.51 —— from f to g.
6 ——————————— 88.51 N.W. from g to h.
16 ——————————— 86.57 S.W. from h to i.
36 ——————————— 83.10. —— from i to k.
57 ——————————— 79.15 —— from k to l.
79 ——————————— 75.15 —— from l to m.
0 Min. ·· 156 Min. : : T. 45d. ·· T. 72d. 14m. SW. from m to C.

For the Diſtances, the Proportions are,

S. 12d. 57m. ·· 43 Min. : : S. 90d. ·· 191.9 Min. from d to e.
8d. 43m. ·· 29 ——————— 191.4 —— from e to f.
5d. 09m. ·· 16 ——————— 178.2 —— from f to g.
1d. 09m. ·· 04 ——————— 199.3 —— from g to h.
3d. 03m. ·· 10 ——————— 187.9 —— from h to i.
6d. 50m. ·· 22 ——————— 184.9 —— from i to *k*.
10d. 45m. ·· 36 ——————— 193.0 —— from k to l.
14d. 45m. ·· 49 ——————— 192.5 —— from l to m.
17d. 40m. ·· 32 ——————— 104.9 —— from m to C.

Which place orderly as in the Table following.

Places	Places Latitudes.	Meridional Parts.	Mer. Diff. Lat.	Difference of Longitude.	Diff. of Lat.	Courſes from Place to Place.	Diſtances of Places.
	d. m.	Min.	Min.	d. m.	Min.	d. m.	Min.
A	50.00	3474	90	5 or 300	57	N 73.18 W	198.4
d	50.57	3564	69	5 or 300	43	N 77.03 W	191.9
e	51.40	3633	46	5 or 300	29	N 81.17 W	191.4
f	52.09	3679	27	5 or 300	16	N 84.51 W	178.2
g	52.25	3706	6	5 or 300	04	N 88.51 W	199.3
h	52.29	3712	16	5 or 300	10	S 86.57 W	187.9
i	52.19	3696	36	5 or 300	22	S 83.10 W	184.9
k	51.57	3660	57	5 or 300	36	S 79.15 W	193.0
l	51.21	3603	79	5 or 300	49	S 75.15 W	192.5
m	50.32	3524	50	2.36 or 156	32	S 72.14 W	104.9
C	50.00	3474					
			The whole Diſtance is			——	1822.4

But in regard, moſt of the Courſes in the Table are ſo ne the Weſt, you may ſail N. 67d. 30m. Weſterly, or WNW. 940 Min. until you are in the Latitude of 56d. 00m. North; an then S. 67d. 30m. Weſterly, or WSW. 940.4 min. farther, yo will arrive at the Port deſired.

By this means you alter the Latitude 6d. which is conſiderabl in reſpect to the Benefit of Obſervation, beſides the Diſtanc (this way) is but 59 Minutes more than that of a Great Circl and about 43 Minutes more than the parallel or Weſt Diſtanc which is evident if you compare Chapter 4, Section 3, Proble 10, of *Mercator*'s-*Sailing*, in page 101. with this.

Caſe 3. *Two Places differing both in Latitude and Longitud their Latitudes, and Longitudes being given; to find th Diſtance in the Arc of a Great Circle, and all that is requir in Great Circle Sailing.*

Note; When two Places differ both in Latitude and Longitu they lie neither in one Parallel, nor under one Meridian; of wh there are three kinds, *viz.* (1.) one Place under the Equator, a the other in North, or South Latitude; (2.) Both Places North, or both in South Latitude: And (3.) One Place North Latitude, and the other Place in South Latitude.

Th

Plate 5. Fig. II.

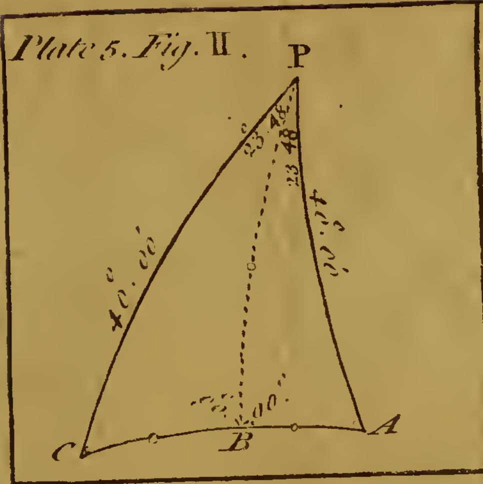


Plate 5. Fig. III.

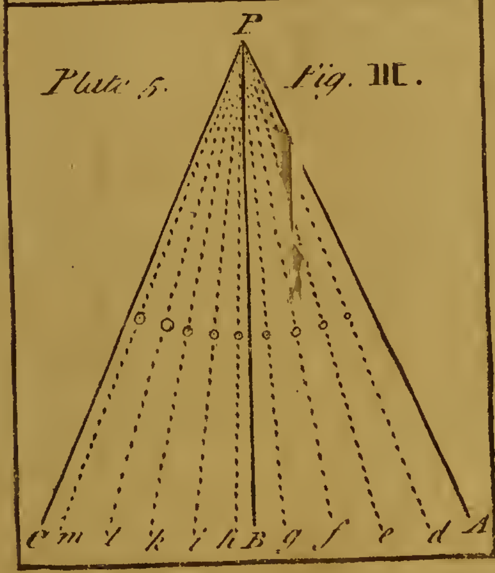
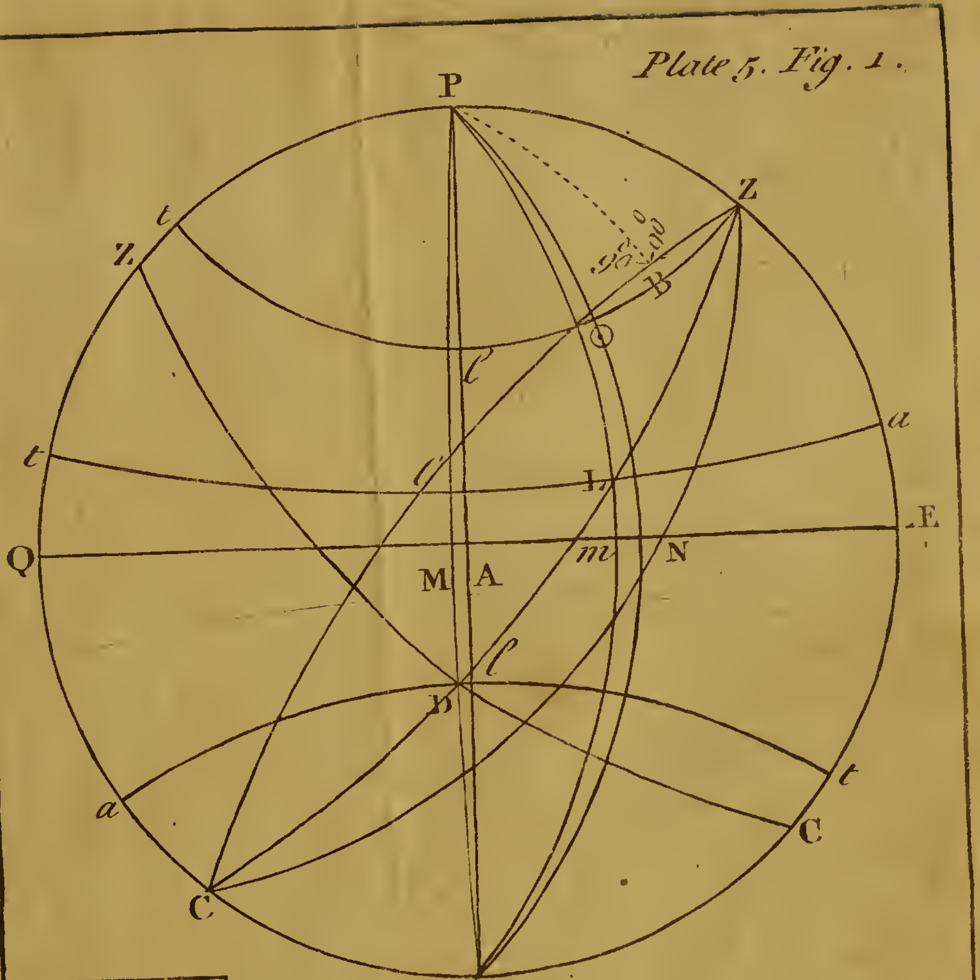


Plate 5. Fig. 1.



Place this next after Pag. 196.

Theſe three Kinds of Places, differing both in Latitude and Lon-itude ; how to find their Diſtance in the Arc of a great Circle, ath been ſhewed in Chap. 7, Section 2, Caſe 3, Problem 6, 7, nd 8, of *Geography*, in pages 185, 186, 187, and 188. But find the Angles of Poſition, and what elſe is requiſite in *Great-ircle-Sailing*, is the Work of the three following Problems.

afe 3. The firſt Kind, *One Place under the Equator, the other in North, or South Latitude: As for* Example.

roblem II. *Suppoſe the* Lizard, *and the Entrance of the River* Amazones ; *I demand the Angles of Poſition* ; *the Great Circle's Diſtance between them? The Latitude of the Arc at every* 10 *Degrees Difference of Longitude? with the Courſe and Diſtance of each of them, according to* Mercator?

The Latitude, and Longitude of theſe Places, ſuppoſed to be s follows,

		d. m.		d. m.
izard ——	Latitude	49.57	Longitude	5.14 W.
maz. River		00.00		49.56 W.
Their Difference of Longitude —— ——				44.42 W.

This Problem is delineated by the Directions in *Problem* 6, of *eography*, in page 186 : And here Note ; That,

In the Rectangle Spheric Triangle ZÆN. *Plate* 6. *Figure* 1.

1. Z repreſents the *Lizard*.
2. N the Entrance of *Amazones* River.
3. The Leg Z Æ the Latitude of the *Lizard* 49d. 57m.
4. The Leg Æ N their Difference of Longitude 44d. 42m.
5. Æ Z N the Angle of Poſition at the *Lizard*.
6. Æ N Z the Complement of the Angle of Poſition at *Amazones*, in the Equator.
7. The Hypotenuſe Z N, the Great Circle's Diſtance between hem.

For the Angles Æ N Z, or Æ Z N (by Chapter 5. Section 4 Problem 5, Caſes 13 and 14, of *Spheric Trigonometry Rectangular*, in pages 139 and 140, the Proportions are theſe ;

As Radius, is to the Sine of the Latitude ; So is the Tangent Complement of the Difference of Longitude, to the Tangent Complement of the Angle of Poſition at the Place having Latitude : That is,

As Radius .. S. Leg ÆZ : : T. c. Leg ÆN .. T. c. Angle ÆZN.
AsS. 90d. .. S.49d.57m. : : T. 45d. 18m. .. T. 37d. 43m.
Which ſubtracted from ———————— 90d. 00m.

Reſts the Angle of Poſition at the *Lizard* — 52d. 17m.

And again,

As Radius, is to the Sine of the Difference of Longitude; ſ is the Tangent Complement of the *Lizard*'s Latitude, to th Tangent of the Angle of Poſition at the Place in the Equator That is,

As Radius .. S. Leg ÆN : : T. c. Leg ÆZ .. T. c. Angle ÆNZ.
As S. 90d. .. S. 44d. 42m. : : T. 40d. 03m. .. T. 30d. 36m. th Angle of Poſition at *Amazones*, which ſubtr. from 90d. 00m.

Reſts the Angle ÆNZ —— 59d. 24m.

For the Hypotenuſe ZN the Great Circle's Diſtance betwee them that's found (by Chapter 7. Section 2. Caſe 3. Problem 6 of *Geography*, in pages 185, and 186) to be 62d. 47m. or 376 Minutes.

To find the Latitude by which the Arc ſhall paſs, at every 10 Degrees Difference of Longitude, from Z repreſenting the *Lizard*; obſerve the following *Stereographic* Projection on the Plane of the Equator. *Plate* 6. *Fig.* 1.

1. Deſcribe the Primitive Circle, on the Center P, which repreſents the Pole of the World, through it draw the Right Circle PZÆ, repreſenting the Meridian of the *Lizard*, and from the Half-Tangents lay 40d. 03m. the Complement of it's Latitude from P to Z.

2. On the Primitive Circle lay 44d. 42m. the Difference of Longitude from Æ to N; alſo lay 10 Degrees from Æ to f, from f to g, and ſo on to i.

3. Through Z repreſenting the *Lizard*, and N the Entrance of *Amazones* River, draw the great Circle as ZN.

4. Draw the Right Circles P f, P g, P h, and P i; which are Meridians, and cut the Arc ZN in a, b, c, and d, the reſpective Points or Places whoſe Latitudes are required.

5. Meaſure a f, b g, c h, and d i, on the Scale of Half-Tangents, (the contrary Way) and they ſhew the Latitude of the Arc at thoſe Places; and to find them,

By Spheric Trigonometry.

The ſeveral Right Circles a f, b g, &c. are ſo many Perpendiculars to as many ſeveral Rectangular Spheric Triangles, which have one common Angle ÆNZ, the Complement of the Angle of Poſition at that Place, which is in the Equator, Now in each of theſe Rectangular Spheric Triangles, there is iven a Leg, and its adjacent Angle, to find the other Leg, hich is the Leg oppoſite to the given Angle; that is, in the riangle a f N, there is given the Leg f N, and Angle a N f, to nd the Leg a f, and ſo in all the reſt of the Triangles.

And the ſeveral Legs N f, N g, &c. are found by a continual ubtraction of 10 Degrees from the Difference of Longitude, till ie Remainder be leſs than 10 Degrees: The Remainders I call ertical Arcs, and are thus found;

		d. m.
rom the Arc	ÆN	44.42
ubtract the Arc	Æf	10.00
Remains the Leg	N f	34.42
	N g	24.42
	N h	14.42
	N i	4.42

Then, (by Chapter 5, Section 4. Problem 3. Caſe 7. of Spheric Trigonometry Rectangular, in pages 137 and 138) to find the ſeveral Latitudes of the Arc, the Proportion is thus,

As Radius, is to the Sine of the Vertical Arc;
So is the Tangent Complement of the Angle of Poſition (at ie Place in the Equator) to the Tangent of the Arc's Latitude:
r thus,

s Radius ·· S. Nf, Ng, &c. : : T. Angle a N f ·· T. Leg af, bg, &c.

s S. 90d. ·· S. 34d. 42m. : : T. 59d. 24m. ·· T.	43.54	Latit. of	a
24 42	35.15		b
14 42	23.13		c
4 42	07.53		d.

I have calculated the Latitude of the Arc for every 10 Derees Difference of Longitude, but by the ſame Method the ractitioner may do it for each 5 Degrees, and then it will be iore exact.

The Courſe and Diſtance from each of theſe Points or Places re found (by Chapter 4. Section 3. Problem 2. of *Mercator's-ailing*, in pages 93 and 94) in like manner as in the third Step of ie laſt Problem, and is as followeth.

For the Courſes, the Proportion is,

s Mer. Diff. Lat. ·· Diff. Long. : : Rad. ·· T. of the Courſe req.
s 532 Min. ·· 600 Min. : : T. 45d. ·· T. 48d. 26m. SW. from Z to a

675	41 38	S.W. from	a to b
831	35 50		b to c
958	32 04		c to d
s 474 Min. ·· 282 Min. : : T. 45d. ·· T.	30 45		d to N.

For

2. For the Diſtances, the Proportion is,

As S.c. Courſe ·· Diff. Lat. : : Radius ·· Diſtance required.
As S. 41d. 34m. ·· 363 Min. : : S. 90d. ·· 547.1 Min. from Z to
48d. 22m. ·· 519 ———————— 694.4 } from { a to
54d. 10m. ·· 722 ———————— 890.6 } from { b to
57d. 56m. ·· 920 ———————— 1086.0 } from { c to
59d. 15m. ·· 473 ———————— 550.4 } from { d to N

This may ſerve for a ſufficient Explanation of this Problem the whole is in the Table following.

Places	*Places Latitudes.*	*Meridional Parts.*	*Mer. Diff. Lat.*	*Difference of Longitude.*	*Diff. of Lat.*	*Courſes from Place to Place.*	*Diſtances of Places.*
	d. m.	Min.	Min.	d. m.	d. m.	d. m.	Minutes
Z	49.57	3470	532	10 or 600	6.03	S 48 26 W	547.1
a	43.54	2938	675	10 or 600	8.39	S 41 38 W	694.4
b	35.15	2263	831	10 or 600	12.02	S 35 50 W	890.6
c	23.13	1432	958	10 or 600	15.20	S 32 04 W	1086.0
d	07.53	474	474	4.42 or 282	7.53	S 30 45 W	550.4
N	00.00	·· 0					
				The whole Diſtance is ——			3768.5

Caſe 3. The ſecond kind; *Both Places in North Latitude, o both in South Latitude, as for* Example.

Problem 3. *Suppoſe the* Lizard *and Iſland* Barbadoes: *I deman the Angles of Poſition;* *the* Great Circle's *Diſtance between them* *The* Latitude *of the Arc at every* 10 *Degrees Difference o* Longitude? *With the Courſe and Diſtance from each Point o Place, according to* Mercator?

The Latitude and Longitude of theſe Places, ſuppoſed a follows,

		d.m.		d.m.
Lizard——	Lat.	49.57	Longit	5.14 W.
I. *Barbadoes*	Lat.	12.58	Longit	58.50 W.

Their Difference of Longitude is——53.36 W.

Thi

This Problem is delineated Stereographically, by the Directions n Problem 7, of *Geography*, in pages 186 and 187.

In the Oblique Spheric Triangle PZL. *Plate* 6. *Fig.* 2.

1. Z repreſents the *Lizard*, in Latitude 49d. 57m. North.

2. L the Iſland *Barbadoes*, in Latitude 12d. 58m. North.

3. The Side PZ the Complement of the Latitude of the *Lizard*, 40d. 03m.

4. The Side PL the Complement of the Latitude of *Barbadoes*, 77d. 02m.

5. The Angle ZPL their Difference of Longirude, 53 deg. 36 min.

6. PZL } the Angle of Poſition at { the *Lizard*.
7. PLZ } the Angle of Poſition at { Iſland *Barbadoes*.

8. The Side ZL the Great Circle's Diſtance between them.

For the Angle PZL and PLZ, (by *Chapter* 5, *Section* 5, *Problem* 9, *Caſe* 7, of *Spheric Trigonometry Oblique*, in *Pages* 144 and 145.) the Proportions are theſe;

As the Sine of half the Sum of the Complements of both Latitudes, is to the Sine of half their Difference;

So is the Tangent Complement of half their Difference of Longitude, to the Tangent of half the Difference of the Angles of Poſition: Again,

As the Sine Complement of half the Sum of the Complements of both Latitudes, is to the Sine Complement of half their Difference;

So is the Tangent Complement of half their Difference of Longitude, to the Tangent of half the Sum of the Angles of Poſition: But ſhorter thus,

As S. ½ Sum ſides ·· S. ½ their diff. : : T.c. ½ ZPL ·· T. ½ diff. of Ang.
As S. 58d. 32m. ·· S. 18d. 29m. : : T. 63d. 12m. ·· T. 36d. 21m.

Again,

As S.c. ½ Sum ſides ·· S.c. ½ their diff. : : T.c. ½ ZPL ·· T. ½ Sum Ang.
As S. 31d. 28m. ·· S. 71d. 31m. : : T. 63d. 12m. T. 74d. 28m.
To which the half Difference above being added —— 36d. 21m.
The Sum is the Angle of Poſition at Z———— 110d. 49m.
And ſubtracted is the Angle of Poſition at L —— 38d. 07m.

For the Side ZL, the Diſtance, it's found (by *Chapter* 7. *Section* 2, *Caſe* 3, *Problem* 7, of *Geography*, in *Pages* 187 and 188) to be 57d. 03m. or 3423 Minutes, which is their Diſtance in the Arc of a great Circle.

To find the Latitudes by which the Arc ſhall paſs, at every 10 deg. Difference of Longitude, from Z repreſenting the *Lizard*;

Lizard; deſcribe the Problem Gnomonically, and then all the Parts of it will be right Lines, which is thus done.

The Problem Gnomonically delineated.

1. Make the Angle LPZ equal to 53d. 36m. the Difference of Longitude.

2. Make the Side PZ equal to the Tangent of 40d. 03m. the Complement of the *Lizard's* Latitude.

3. And PL equal to the Tangent of 77d. 02m. the Complement of *Barbadoes* Latitude.

4. Draw the Line LZ, which is the Great Circle's Diſtance, between them, and continue it beyond Z.

5. From P let fall the perpendicular PB to cut LZ in B; which being meaſured on the Scale of Tangents, is 36d. 58m. the Complement of the Arc's greateſt Latitude.

6. Then draw Lines from P, each 10 Degrees diſtant from Z; as Pa, Pc, Pd, Pe, and Pf, which are Meridians, each 10 Degrees of Longitude from the *Lizard*, and from each other.

7. Meaſure Pa, Pc, *&c.* on the Scale of Tangents, and they ſhew. the Complements of the Latitudes of the Arc, at the reſpective Places, a, c, d, *&c.*

These are found by Calculation after this manner,

Firſt. In the Rectangle Spheric Triangle PBZ; there is given the $\left\{\begin{array}{l}\text{Hypot. PZ 40d. 03m.}\\ \text{Angle PZB 69d. 11m.}\end{array}\right\}$ to find the $\left\{\begin{array}{l}\text{Leg BP.}\\ \text{Angle BPZ.}\end{array}\right.$

Which, by *Chapter* 5. *Section* 4. *Problem* 2. *Caſes* 4. and 6. of *Spheric Trigonometry Rectangular*, in *Pages* 136 and 137, is thus,

1. For the Leg PB, the Complement of the Arc's greateſt Latitude, thus:

As the Radius, is to the Sine Complement of the greateſt given Latitude;

So is the Sine of the Angle of Poſition (at that Place,) to the Sine Complement of the Arc's greateſt Latitude; That is,

As Radius ·· S.Hypot. PZ : : S. Angle PZB ·· S. Leg PB.

As S. 90d. ·· S. 40d. 03m. : : S. 69d. 11m. ·· S. 36d. 58m. which being ſubtracted from ———————— 90d. 00m.

reſts the Arcs greateſt Latitude ———————— 53d. 02m.

2. For the Vertical Angle BPZ, it's thus;

As Radius, is to the Sine of the greateſt given Latitude;

So is the Tangent of the Angle of Poſition (at that Place,) to the Tangent of the Complement of the Vertical Angle: That is,

As

s Radius ·· S.c.Hypot. PZ : : T. Angle PZB ·· T.c. Angle BPZ.
sS. 90d. ·· S. 49d. 57m. : : T. 69d. 11m. ·· T. 63d. 35m.
which being ſubtracted from ———————— 90d. 00m.

Reſts the Vertical Angle BPZ———————— 26d. 25m.

Secondly, To find the ſeveral Latitudes of the Arc at a, c, d, *c.* you may conſider, that the ſeveral prick'd Lines, Pa, Pc, *c.* are ſo many Hypotenuſes, to as many ſeveral Rectangle-pheric Triangles which have one common Leg PB, the Com-ement of the Arc's greateſt Latitude.

In each of them, there is given a Leg, and it's adjacent An-e, to find the Hypotenuſe: that is, in the Triangle PBa, there is ven the Leg PB, and Angle BPa, to find the Hypotenuſe Pa; id ſo in all the reſt.

And the ſeveral Vertical Angles B P a, B P c, B P d, *&c.* e found by a continual Addition of 10 Degrees, to the Angle PZ, 26d. 25m. till the Sum exceed not 80d. 01m. the Diffe-nce of Longitude given, added to the foreſaid 26d. 25m. That ;

d. m.
o the Angle BPZ 26.25
dd the Angle ZPa 10.00
————
Sum is the Ang. BPa 36.25
BPc 46.25
BPd 56.25
BPe 66.25
BPf 76.25

Theſe Vertical Angles being thus found, the ſeveral Latitudes of the Arc at a, c, d, e, and f, are found by Chapter 5, Sect. 4. Problem 3. Caſe 9. of Spheric Trigonometry Rectangular, in pages 137 and 138, the Proportion being the ſame before, in Caſe 2. Prob. 1. of this Chap. in pages 190 and 193, id is as followeth,

As Radius, is to the Sine Complement of the Vertical Angle; is the Tangent of the Arc's greateſt Latitude, to the Tangent the Arc's Latitude required: Or thus;

s Rad. ·· S.Co. BPa, BPc, *&c.* : : T.c. Leg BP ·· T.c. Pa, Pc, *&c.*
sS. 90d. ·· S. 53d. 35m. : : T. 53d. 02m. ·· T. 46.55 —— a
43d. 35m. ———————— 42.29 Lati- c
33d. 35m. ———————— 36.19 tude d
23d. 35m. ———————— 28.00 of e
13d. 35m. ———————— 17.20 —— f

Which Latitudes, place in the Table following.

Thirdly,

Places	*Places Latitudes*	*Meridional Parts.*	*Mer. Diff. Lat.*	*Difference of Longitude.*	*Diff. of Lat.*	*Courſes from Place to Place.*	*Diſt. of Places.*
	d. m.	Min.	Min.	d. m.	d. m.	d. m.	Min.
Z	49.57	3470	275	10 or 600	3.02	S 65.23 W	436.9
a	46.55	3195	374	10 or 600	4.26	S 58.04 W	502.9
c	42.29	2821	479	10 or 600	6.10	S 51.24 W	593.1
d	36.19	2342	591	10 or 600	8.19	S 45.26 W	711.1
e	28.00	1751	695	10 or 600	10.40	S 40.48 W	845.4
f	17.20	1056	271	3.36 or 216	4.22	S 38.33 W	335.0
L	12.58	785					
The whole Diſtance							3424.4

Thirdly, The Courſe and Diſtance in the two laſt Column of this Table, are found by Chapter 4, Section 3, Problem 2, c *Mercator's Sailing*, in pages 93 and 94, in the ſame manner a in the two laſt Problems in this Chapter; thus,

1. For the Courſes, the Proportion is,

As *Mer. Diff. Lat.* ·· *Diff. Long.* : : *Radius* ·· T. *of the Courſe* rec
As 275 ·· 600m. : : T. 45d. ·· T. 65d. 23m. SW. from Z to
374 ———————— 58d. 04m. a to
479 ———————— 51d. 24m. SW. c to
591 ———————— 45d. 26m. from d to
695 ———————— 40d. 48m. e to
271m. ·· 216m. : : T. 45d. ·· T. 38d. 33m. f to I

2. For the Diſtances, the Proportion is,

As S.c. Courſe ·· Diff. Lat. : : Radius ·· Diſtance required.
As S. 24d. 37m. ·· 182 Min. : : S. 90d. ·· 436.9 Min. from Z to
31d. 56m. ·· 266 ———————— 502.9 a to
38d. 36m. ·· 370 ———————— 593.1 c to
44d. 34m. ·· 499 ———————— 711.1 from d to
49d. 12m. ·· 640 ———————— 845.4 e to
51d. 27m. ·· 262 ———————— 335.0 f to I

Thus is this third Problem ſufficiently explained in every Pa of it.

Caſe 3. The Third Kind; *One Place in North Latitude an the other in South Latitude, as for Example.*

Problem 4. *Suppoſe* Cape Cod *in* New-England, *and* Cap Bona Eſperance: *I demand the Angles of Poſition? The Gre Circles Diſtance between them? The Latitude of the Arc eve* *very* 10 *Degrees Difference of Longitude? with the Courſe and iſtance of each each according to* Mercator?

The Latitude and Longitude of theſe Places, ſuppoſed to be as ollows;

		d. m.		d. m.
ape *Cod*	Lat.	42.12 N.	Longit.	68.55 Weſt
ape *Bona Eſper.*		34.07 S.		19.35 Eaſt
Their Difference of Longitude				88.30 Eaſt

In the Oblique Spheric Triangle PZD. *Plate* 6. *Fig.* 3.

1. Z repreſents Cape *Cod*, in Latitude 42d. 12m. North.
2. D Cape *Bona Eſperance*, in Latitude 34d. 07m. South.
3. The Side PZ the Complement of the Latitude of C. *Cod*, 47d. 48m.
4. The Side PD, the Diſtance of Cape *Bona Eſperance*, from the North Pole, which is its Latitude added to 90 Degrees equal to 124d. 07m.
5. The Angle ZPD their Difference of Longitude, 88d. 30m.
6. PZD } the Angle of Poſition at Cape { *Cod.*
7. PDZ } { *Bona Eſperance.*
8. The Side Z D the Great Circle's Diſtance between them.

For the Angles P Z D and P D Z, (by Chapter 5. Section 5. Problem 9, Caſe 7, in pages 144, *&c.*) the Proportions are,

		d. m.		d. m.		d. m.
Side	PD	124.07			The Angle DPZ	88.30
	PZ	47.48				
					The half is ——	44.15
The Sum		171.55	The half Sum	85.57	Which ſub. from	90.00
The Diff.		76.19	The half Diff.	38.09	Its Complement	45.45

As S. ½ *Sum ſides* ·· S½ *their Diff.* : : T.c. ZPD ·· T.½ *Diff. Ang.* req.
As S. 85d. 57m. ·· S. 38d. 09m. : : T. 45d. 45m. ·· T. 32d. 27m.
As S. 04d. 03m. ·· S. 51d. 51m. ———————— 85d. 00m.
Added, giveth the greater Angle PZD ——— 117d. 27m.
Subtracted is the leſs Angle P D Z ——— 52d. 33m.

The Diſtance ZD is found (by Chapter 5. Section 3, Caſe 3, Problem 8, of Geography) in pages 188 and 189, to be 111d. 09m. or 6669 Minutes.

To find the Latitude by which the Arc ſhall paſs at each 10 Degrees Difference of Longitude from Z, repreſenting Cape *Cod*; deſcribe the Problem Stereographically on the Plane of the Equator, and then all the Meridians will be Right Circles.

To delineate this Problem Stereographically, Plate 6. *Fig.* 3.

1. Deſcribe the Primitive Circle, and make the Angle DPZ equal to 88d. 30m. the Difference of Longitude, (by Chapter 5. Section 1. Problem 2. Caſe 1. in page 112. of *Spheric Geometry*) by drawing two Right Circles.

2. Make the Side PZ equal to the Half Tangent of 47d. 48m. the Complement of the Latitude of Cape *Cod.*

3. Make PD equal to the Half Tangent of 124d. 07m. (the Latitude of Cape *Bona Eſperance* added to 90d.) by Chap. 5. Sect. 1. Prob. 6. Caſe 2. of *Spheric Geometry*, in pages 116 and 117.

4. Then by Chapter 5. Section 1. Problem 4. of *Spheric Geometry* (in pages 113 and 114) through Z and D draw a Great Circle.

5. From P (by Problem 5. of *Spheric Geometry*, in page 114) let fall the Perpendicular PB, to cut ZD in B; which being meaſured on the Scale of Half-Tangents, is 41d. 06m. the Complement of the Arc's greateſt Latitude.

6. Then draw Lines from P, each 10d. diſtant in the Arc from Z; as Pa, Pc, Pd, Pe, &c. which are Meridians, each 10d. of *Longitude* from one another, and from the Meridian of *Cape Cod.*

7. Meaſure Pa, Pc, &c. on the Scale of Half Tangents, and they ſhew the Complements of the Latitudes of the Arc at the reſpective Places, a, c, d, &c.

Theſe are found by Calculation after this Manner, which is in all Reſpects like the Work of the laſt Problem.

Firſt, In the Rectangle Spheric Triangle PBZ.

1. For the Leg BP, the Complement of the Arc's greateſt Latitude, it's thus:

As Radius ·· S. Hypot. PZ : : S. Angle PZB ·· S. Leg. PB.
As S. 90d. ·· S. 47d. 48m. : : S. 62d. 33m. ·· S. 41d. 06m.
Which ſubtracted from ———— 90d. 00m.

Reſts the Arc's greateſt Latitude —— 48d. 54m.

2. For the Vertical Angle PZB, it's thus;

As Radius ·· S.c. Hypot. PZ : : T. Angle PZB ·· T.c. Angle BPZ
As S. 90d. ·· S. 42d. 12m. : : T. 62d. 33m. ·· T. 52d. 17m.
Which ſubtracted from ———— 90d. 00m.

Reſts the Vertical Angle BPZ ———— 37d. 43m.

Secondly, For the ſeveral Latitudes at a, c, d, &c. add 10d. to Angle BPZ (in Continuation) Eight times, which produceth the ſeveral Vertical Angles, BPa, BPc, BPd, &c.

		d. m.
To the Angle BPZ ——		37.43
Add the Angle ZPa ——		10.00
Sum, is the Angle	BPa	47.43
	BPc	57.43
	BPd	67.43
	BPe	77.43
	BPf	87.43
	BPg	97.43
	BPh	107.43
	BPi	117.43

Theſe Vertical Angles being thus found, the ſeveral Latitudes of the Arc, at a, c, d, e, f, g, h, and i, are found by Chapter 5. Section 4. Problem 3. Caſe 9. of Spheric Trigonometry Rectangular; the Proportions being the ſame as before in Caſe 2. Problem 1. of this Chapter, in pages 193, and 194, as follow,

As the Radius, is to the Sine Complement of the Vertical Angle; So is the Tangent of the Arc's greateſt Latitude, to the Tangent of the Arc's Latitude required: Or thus,

As Radius ·· S.c. BPa, BPc, *&c.* : : T.c. Leg BP ·· T.c. Pa, Pc, Pd, *&c.*

As S. 90d. ·· S. 42d. 17m. : : T. 48d. 54m. ··	T. 37.38	Latitude of	a
32d. 17m. ——————	31.29		c
22d. 17m. ——————	23.30		d
12d. 17m. ——————	13.42		e
02d. 17m. ——————	02.37		f
07d. 43m. ——————	08.45		g
17d. 43m. ——————	19.14		h
27d. 43m. ——————	28.04		i

Thirdly, For the Courſes, and Diſtances, they are found by Chapter 4, Section 3, Problem 2, of *Mercator's* Sailing, in pages 93 and 94, as follow,

For the Courſes, the Proportion is,

Mer. Diff. Lat. ·· Diff. Long. : : Radius ·· T. Courſe.

As 358 Min. ·· 600 Min. : : T. 45d. ·· T. 59d. 11m SE. from Z to a			
448 ——————	53d. 15m.	S.E. from	a to c
541 ——————	47d. 58m.		c to d
621 ——————	44d. 01m.		d to e
673 ——————	41d. 43m.		e to f
684 ——————	41d. 15m.		f to g
649 ——————	42d. 45m.		g to h
580 ——————	45d. 58m.		h to i:
As 423 Min. ·· 510 min. : : T. 45d. T.	54d. 49m.		i to D.

For

2. For the Diſtances, the Proportion is,

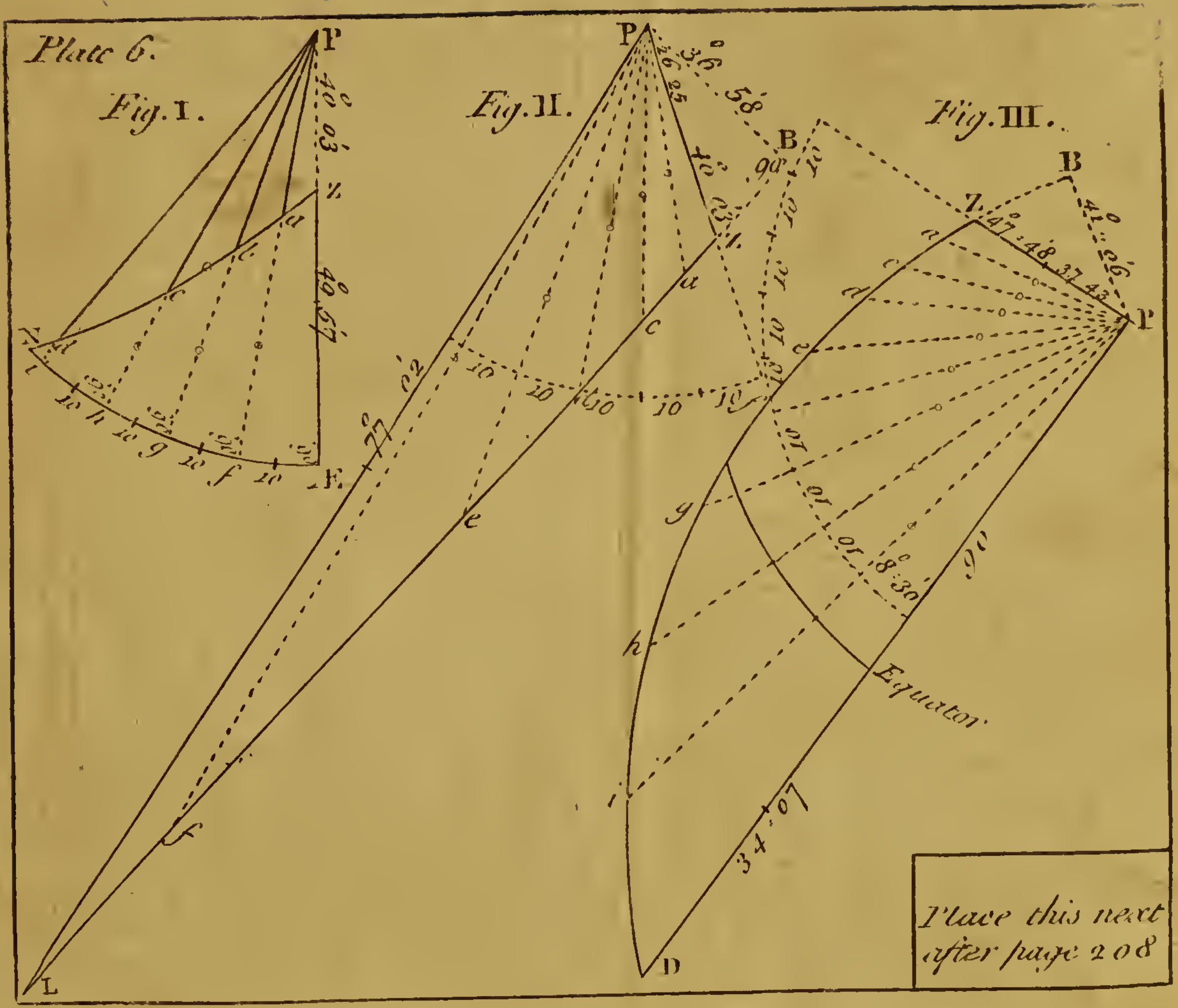
As S.c. Courſe ·· Diff. Lat. : : Radius ·· Diſtance required.
As S. 30d. 49m. ·· 274m. : : S. 90d. ·· 534.9m. from Z to a
36d. 45m. ·· 369 ———— 616.7 from a to c
42d. 02m. ·· 479 ———— 715.4 from c to d
45d. 59m. ·· 588 ———— 817.6 from d to e
48d. 17m. ·· 665 ———— 890.9 from e to f
48d. 45m. ·· 682 ———— 907.1 from f to g
47d. 15m. ·· 629 ———— 856.6 from g to h
44d. 02m. ·· 530 ———— 762.5 from h to i
35d. 11m. ·· 363 ———— 630.0 from i to D.

Which place orderly, as in the Table following, and its finiſh'd.

Places	*Places Latitudes.*	*Meridional Parts.*	*Merid. Diff. Lat.*	*Difference of Longitude.*	*Diff. of Lat.*	*Courſes from Place to Places.*	*Diſt. of Places.*
	d. m.	Min.	Min.	d. m.	d. m.	d. m.	Min.
Z	42.12 N	2798	358	10 or 600	4.34	S 59.11 E	534.9
a	37.38	2440	448	10 or 600	6.09	S 53.15 E	616.7
c	31.29	1992	541	10 or 600	7.59	S 47.58 E	715.4
d	23.30	1451	621	10 or 600	9.48	S 44.01 E	817.6
e	13.42	830	673	10 or 600	11.05	S 41.43 E	890.9
f	02.37 N	157	684	10 or 600	11.22	S 41.15 E	907.1
g	08.45 S	527	649	10 or 600	10.29	S 42.45 E	856.6
h	19.14	1176	580	10 or 600	8.50	S 45.58 E	762.5
i	28.04	1756	423	8.30 or 510	6.03	S 54.49 E	630.0
D	34.07	2179					
			The whole Diſtance is——				6731.7

Note; The Arc of a great Circle may be deſcribed on a *Mercator*'s Chart, and thereby much of the Calculative Work ſpared; for having the ſeveral Latitudes of the Arc at every 5, or 10 Degrees Difference of Longitude, by *Chapter* 4, *Section* 1, *Problem* 1 and 2, of the Uſe of *Mercator's* Chart, in *Pages* 84 and 85, thoſe Places may be prick'd down in the Chart, and then with a Black Lead Pencil, draw Lines from place to place, which will repreſent the Great Circle, and by *Problem* 3 and 4, of the Uſes of that Chart, in *Page* 85, the

Plate 6.



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the Courſes and Diſtances from each other may be found, and at any Time thoſe Lines may be wiped out, and the Chart fit to ſerve at any other Time, or for any other Place.

So that any Problem, being thus drawn, in a *Mercator's Chart*, the nearer a Ship ſails to it, the nearer to a *Great Circle* ſhe makes her Way good, and conſequently the ſhorter her Paſſage, and this is the chief Uſe, and Application of *Great Circle Sailing*, of which I have given a ſufficient Explanation.

Thus is finiſhed the *Third Part of Navigation*, or the *Third Kind of Sailing*, and now we paſs to *Aſtronomy*.

CHAPTER IX.

Spheric Trigonometry *applied in ſundry* Aſtronomic Problems, *uſed in the* Art of Navigation.

WHAT a *Spheric* or *Globe* is, and the Circles generally drawn on it hath been taught (Chapter 6, Section 2, and 3,) in the Deſcription of both Globes: But how theſe are drawn on a Plane, and form divers Triangles (from whence Multitudes of uſeful and pleaſant Problems may be framed) is our preſent Work.

Section I. *Aſtronomic Definitions.*

THE Circles drawn upon the Sphere's Surface are either Great, or Leſs Circles.

I. *The* Great Circles, *and their* Poles *deſcribed.*

Great Circles, are thoſe which divide the Globe, or Sphere into two equal Parts, and are principally theſe Six: the Equinoctial, Ecliptic, Meridian, Horizon, Azimuth, and Circle of Longitude.

1. The *Equinoctial*, is a great Circle which lies in the Middle, between the two Poles of the World, and conſequently each Pole is 90 Degrees diſtant from it, cutting all Meridians at Right Angles, and divides the World into the Northern and Southern Hemiſpheres, as the Right Circle ÆAQ. in *Plate* 7. *Figure* 1 and 2.

The Poles of the World are two fixed Points in the Heavens, diametrically oppoſite to each other, the one in the Northern Hemiſphere, called the (Artic or) North Pole, the other in the Southern Hemiſphere, called the (Antartic or) South Pole, as P and I. *Plate* 7. *Figure* 1 and 2.

The Axis of the World, is an imaginary Line drawn from Pole to Pole, about which the Diurnal Motion (according to the *Copernic* Syſtem) from Weſt to Eaſt, is performed; as PAI.

2. The *Ecliptic* (is a great Circle) croſſing the Equinoctial in (two oppoſite Points) the Beginning of *Aries* and *Libra*, making an Angle (called its Obliquity) of 23d. 29m. as the Right Circle, ♋ A ♑. *Plate* 7. *Fig.* 1.

This Circle is divided into Twelve equal Parts called Signs, each containing 30 deg. whoſe Names and Characters follow.

Aries	♈	called Northern Signs.	*Libra* - - -	♎	called Southern Signs.
Taurus	♉		*Scorpio* - - -	♏	
Gemini	♊		*Sagittarius*	♐	
Cancer	♋		*Capricornus*	♑	
Leo	♌		*Aquarius* -	♒	
Virgo	♍		*Piſces* - -	♓	

The *Zodiac*, is a Zone or Girdle, having eight Degrees of Latitude on each Side the Ecliptic; in which Space the Planets make their Revolutions, being divided and diſtinguiſhed by the Twelve Signs.

The Poles of the *Ecliptic*, are two oppoſite Points 23d. 29m. diſtant from the Poles of the World; as K and L.

3. The *Meridians* are great Circles, paſſing through both Poles of the World, and croſs the Equinoctial at Right Angles, as PÆI, and PMI, *&c.* *Plate* 7. *Fig.* 1*ſt* and 2*d.*

The *Colures*, are two Meridians dividing the Equinoctial and Ecliptic into four equal Parts; one of theſe paſſeth by the Equinoctial Points, *Aries* and *Libra*, and is called the Equinoctial Colure; as PAI. *Plate* 7. *Fig.* 1.

The other paſſeth by the Beginning of *Cancer* and *Capricorn*, and is called the *Solſtitial Colure*; as P ♋ ÆI ♑ Q. *Plate* 7. *Fig.* 1.

The Sun's *Meridian*, is that Meridian which paſſeth over the Sun's Center.

A Star's *Meridian*, is that Meridian which paſſeth thro' the Middle of that Star.

4. The *Horizon*, is a great Circle 90 deg. diſtant from the Zenith and Nadir, cutting all Azimuths at Right Angles, an dividing the World into two equal Parts, the upper and viſibl Hemiſphere, and the lower and inviſible Hemiſphere. This Circl is repreſented by the Right Circle SAB. *Plate* 7. *Fig.* 2.

The *Zenith* and *Nadir*, are two Points diametrically oppoſite, and are the Poles of the Horizon: The Zenith is the Vertica Point, or Point right over our Heads, as Z; the Nadir is directl oppoſite thereto, as N. *Plate* 7. *Fig.* 2.

5. The *Azimuth*, or *Vertical Circles*, are great Circles concurring and interſecting each other in the Zenith and Nadir an

and croſs the Horizon at Right Angles, as ZCN, and ZAN, &c.

The *Prime Vertical*, is that Azimuth Circle, which paſſeth through the Eaſt and Weſt Points of the Horizon, as the Right Circle ZAN.

The *Meridian of a Place*, is that Meridian which paſſeth hro' the Poles of the World, and the Zenith and Nadir of the aid Place, as ZPBNISÆZ, *Plate* 7. *Fig.* 2.

6. Circles of *Longitude*, are great Circles interſecting each ther in the Poles of the Ecliptic, as KAL, and KVL, *Plate* 7. *Figure* 1.

II. *The Leſs Circles defined.*

Leſs or *Small Circles*, are thoſe which divide the Sphere into wo unequal Parts, and are drawn parallel to ſome great Circle, nd therefore are called Parallel Circles; and are of three Kinds, iz. *Parallels of Declination*, *Parallels of Latitude*, and *Paral-ls of Altitude.*

1. *Parallels of Declination* are (ſmall Circles) parallel to the quinoctial, imagined to paſs through every Degree and Minute f the Meridian, between the Equinoctial and each Pole of the Vorld, as ♋ f g, and ♑ h t. *Plate* 7. *Fig.* 2.

The *Tropic's* are two Parallels of Declination, 23d. 29m. diant from the Equinoctial, limiting the Sun's greateſt Declination.

The North *Tropic*, paſſeth by the Beginning of *Cancer*, and is lled the Tropic of *Cancer*; as ♋ f g. *Plate* 7. *Fig.* 1.

The South *Tropic*, paſſeth by the Beginning of *Capricorn*, and called the Tropic of *Capricorn*; as ♑ h i. *Plate* 7. *Fig.* 1.

The *Polar Circles*, are two Parallels of Declination, 66d. 31m. ſtant from the Equinoctial, and 23d. 29m. from each Pole of e World.

That which is adjacent to the North Pole is called the *Artic ircle*; as K n o; and the other the *Antartic Circle*; as L p r, *late* 7. *Fig.* 1.

2. *Parallels of Latitude*, are (ſmall Circles) parallel to the cliptic, imagined to paſs through every Degree and Minute of e Colures, between the Ecliptic and the Poles thereof, as w x y, *late* 7. *Fig.* 1.

3. *Almicanters*, or *Parallels of Altitude*, are (ſmall Circles) pallel to the Horizon, imagined to paſs through every Degree and inute of the Meridian, between the Horizon and the Zenith, a l t. *Plate* 7. *Fig.* 2.

Theſe Definitions compared with Chapter 6. Section 4. (the Uſe of the Cœleſtial Globe, in Pages 168 and 169.) an well conſider'd, will make way for the underſtanding the follow ing Problems.

Section II. *Spheric Trigonometry Rectangular, applied in Aſtron mic Problems, uſeful in Navigation.*

AND becauſe the Sun's Place in the Ecliptic, is the Groun of the ſucceeding Problems, you have here (out of M *Tho. Street*'s Memorial Verſes on the Eccleſiaſtic and Civil Ca lendar) a General Rule; which for common Uſes may ſerve, an is as follows.

1. *To know the Day of the Month the Sun entereth any of t* Twelve Signs.

The Rule. Twice twent', twice one, 4 threes, twice two;
Then twenty, nineteen, that will do.

That is, counting *March* the firſt Month, the Sun enters

♈	*March*	20	♌	*July*	23	♐	*November*	2
♉	*April*	20	♍	*Auguſt*	23	♑	*December*	2
♊	*May*	21	♎	*September*	23	♒	*January*	2
♋	*June*	21	♏	*October*	23	♓	*Februaay*	1

2. *To find the Degree of the Sun's Place on any given Day.*

The Rule. From the Day of the Month given, (if you ca ſubſtract the Day of his Entrance into the Sign of that Mont the Remainder is the Degree of the Sun's Place in that Sig Or elſe,

When you can't ſubſtract, add 30 to the Day given; and fro the Sum ſubſtract the Day of his Entrance into the Sign of th Month, the Remainder will be the Degree of his Place in t Sign preceding the Month given.

Example 1. *March* 31ſt, I deſire to know the Sun's Place?

From *March* the 31ſt, the Day given; ſubſtract the Sun's E trance, ♈ *March* 20.

The Remainder 11 is the Degree of the Sun's Place in ♈.

Example 2. *May* the 15th, I deſire to know the Sun's Plac

To the Day given *May* the 15th.
Add ——————— 30
Sum is ——— ——— —— 45 from which
Subſtract the Sun's Entrance into ♊ *May* 21
Remainder is the Sun's Place in ♉ ——— 24 Degrees.

Proble

Problem 1. The Sun's Place in the Ecliptic, and his greateſt Declination given; to find his Right Aſcenſion, and preſent Declination.

Definition 1. *Aſcenſion*, is the Riſing of the Sun, Star or any Part of the Equinoctial above the Horizon; and Deſcenſion is the Setting thereof.

2. *Right Aſcenſion*, is an Arc of the Equinoctial, intercepted between the Beginning of *Aries*, and any Meridian, and counted according to the Order, or Succeſſion of the Signs: Or, it's that Degree and Minute of the Equinoctial (counted as before) which cometh to the Meridian with the Sun, Star, or with any Part of the Ecliptic; as AM. *Plate* 7. *Fig.* 1.

3. *Declination*, is an Arc of a Meridian contained between the Sun, or Star's Center, and the Equinoctial, as MC.

4. The Sun's greateſt Declination is an Arc of the Solſtitial Colure, contained between the Equinoctial and the Ecliptic, and is equal to 23d. 29m. as Æ ♋, and Q ♑. *Plate* 7. *Fig.* 1.

Example. The Sun in *Taurus*, 24d. 15m. I demand his Right Aſcenſion and Declination?

In the Rectangle Spheric Triangle AMC. *Plate* 7. *Fig.* 1.

1. AMC the Right Angle.
2. AC the Sun's Longitude from the next Equinoctial Point.
3. AM his Right Aſcenſion from the ſame Point.
4. MAC the Sun's greateſt Declination, equal to 23d. 29m.
5. MC his preſent Declination.

Note; the Sun in ♈, ♉, ♊, ♑, ♒, ♓, the neareſt Equinoctial Point is the Beginning of ♈: But when the Sun is in ♋, ♌, ♍, ♎, ♏, or ♐, the neareſt Equinoctial Point is ♎.

So that in this Problem, the Sun being in ♉ 24d. 15m. he is 54d. 15m. from the neareſt Equinoctial Point ♈.

To project this Problem *Stereographically* on the Plane of the Solſtitial Colure.

1. Deſcribe the Primitive Circle with a Chord of 60 Degrees, and quarter it, with two Right Circles, ÆAQ (the Equinoctial) and PAI (the Equinoctial Colure) placing A at the Center of the ſaid Primitive Circle, which now is the Solſtitial Colure.

2. Make (by Problem 2. Caſe 1. of *Spheric Geometry*, in Page 112.) the Angle ÆA ♋ equal to 23d. 29m. (the Sun's greateſt Declination) by laying the Chord of it, from Æ to ♋, and drawing the Right Circle ♋ A ♑ the Ecliptic.

3. The Ecliptic is divided into the 12 Signs, each 30d. from the Scale of half Tangents, by Problem 6. Caſe 2 of *Spheric Geometry*, in Pages 116 and 117.

4. On the Ecliptic make AC equal to 54d. 15m. (from the Scale of Half-Tangents) by the ſame *Problem* 6. *Caſe* 2.

5. Then (by *Chapter* 5, *Section* 1, *Problem* 5, *Caſe* 3, of *Sphe-ric Geometry*, in Page 115.) draw from C a great Circle perpen-dicular to ÆAQ, as in the Oblique Circle PCMI, to cut ÆAQ in M, and it's done.

For in the Rectangle-Spheric-Triangle AMC, the Legs AM and MC are the two Things required, and may be meaſured b Chapter 5, Section 1, Problem 7, Caſes 2 and 3, of Spheric Geometry, in Page 118.

But by Spheric Trigonometry, having the Hypotenuſe and on Angle given, the Proportions are as follow.

1. To find the Sun's Right Aſcenſion, by Chapter 5, Section 4 Problem 2, Caſe 5, of Spheric Trigonometry Rectangular, i Pages 136 and 137, it's thus;

As the Radius, is to the Sine Complement of the Sun's greate Declination;

So is the Tangent of the Sun's Longitude from the neareſt Equi-noctial Point, to the Tangent of the Sun's Right Aſcenſion, fron the ſaid Point. Or thus;

As Radius .. S. c. Angle MAC : : T. Hypot. AC .. T. Leg AM.
As S. 90d. .. S. 66d. 31m. : : T. 54d. 15m. .. T. 51d. 52m.

Note; This Proportion finds the Sun's Right Aſcenſion onl when he is in the firſt Quarter of the Ecliptic; that is, in ♈, ♉ or ♊: But when the Sun is in the ſecond Quarter ♋, ♌, or ♍ it muſt be ſubſtracted from 180d. and when he is in ♎, ♏, or ♐ it muſt be added to 180d. and in the laſt Quarter ♑, ♒, or ♓ that found by this Proportion, muſt be ſubſtracted from 360d. an and ſo you will have the Sun's Right Aſcenſion from ♈, (for an Place in the Ecliptic) deſired.

2. To find the Sun's preſent Declination, by Chapter 5, Sec-tion 4, Problem 2, Caſe 4, of Spheric Trigonometry Rectangu-lar, in Page 136, it's thus;

As the Radius, is to the Sine of the Sun's Longitude from th neareſt Equinoctial Point;

So is the Sine of the Sun's greateſt Declination, to the Sine o the Sun's preſent Declination. Or thus;

As Radius .. S. Hypot. AC : : S. Angle MAC .. S. Leg MC.
As S. 90d. .. S. 54d. 15m. : : S. 23d. 29m. .. S. 18d. 52m.

Note; The Sun being in any of the Northern Signs, ♈, ♉, ♊ ♋, ♌, or ♍, his Declination is North; but when in any of th Southern Signs ♎, ♏, ♐, ♑, ♒, or ♓, his Declination is South.

In this Rectangle-Spheric-Triangle AMC (Plate 7. Figure 1. may the two ſucceeding Problems be reſolved.

Problen

Problem 2. The Sun's Right Aſcenſion given; to find his Place in the Ecliptic, and his Declination?

Example. The Sun's Right Aſcenſion 128d. 9m. where is his Place in the Ecliptic, and what is his Declination?

Here is one Leg and its adjacent Angle given; to wit, the Leg AM 51d. 51m. the Right Aſcenſion (ſubſtracted from 180d.) and Angle MAC 23d. 29m. the Sun's greateſt Declination; which Triangle is made by Problem 12, of *Spheric Trigonometry Geometric*, in Page 125, and its Solution is by Chapter 5, Section 4, Problem 3, Caſes 7 and 9, of *Spheric Trigonometry Rectangular*, in Pages 137 and 138, or thus;

1. For the Sun's Place in the Ecliptic, it's thus;

T. Leg AM .. Radius : : S. c. Angle MAC .. T. c. Hyp. AC, or
As Radius .. S. c. Ang. MAC : : T. c. Leg AM .. T. c. Hyp. AC.
S. 90d. .. S. 66d. 31m. : : T. 38d. 09m. .. T. 35d. 46m.
Which ſubſtracted from — — —— — — 90d. 00m.
Reſteth the Sun's Longitude — — — — 54d. 14m.
wanting of ♎; ſo that his Place is 5d. 46m. in ♌.

2. For the Sun's preſent Declination, it's thus,

As T. c. Angle MAC .. Radius : : S. Leg AM .. T. Leg MC, or
As Radius .. S. Leg AM : : T. Angle MAC .. T. Leg MC.
As S. 90d. .. S. 51d. 51m. : : T. 23d. 29m. .. T. 18d. 52m.
he Sun's Declination North decreaſing.

Problem 3. The Sun's Declination given; to find his Place in the Ecliptic, and Right Aſcenſion?

Example. The Sun's Declination 16d. 39m. South increaſing: I demand his Place in the Ecliptic, and his Right Aſcenſion?

Here is a Leg and its oppoſite Angle given; that is, the Angle MAC 23d. 29m. the Sun's greateſt Declination, and the Leg MC 16d. 39m. his preſent Declination, which Triangle is made by Problem 13, of *Spheric Trigonometry Geometric*, in Page 126; whoſe Solution is by Chapter 5, Section 4, Problem 4, Caſes 10 and 12, of *Spheric Trigonometry Rectangular*, in Pages 138 and 139, thus; 1. To find his Place in the Ecliptic, it's thus;

As S. Angle MAC .. Radius : : S. Leg MC .. S. Hypot. AC.
As S. 23d. 29m. .. S. 90d. : : S. 16d. 39m. .. S. 45d. 59m.
the Sun's Longitude beyond ♎, becauſe his Declination is South increaſing; ſo that the Sun's Place is 15d. 59m. in ♏.

2. For his Right Aſcenſion, 'tis thus;

Radius .. T. c. Angle MAC : : T. Leg MC .. S. Leg AM.
T. 45d. .. T. 66d. 31m. : : T. 16d. 39m. .. S. 43d. 30m.
To which add — — — — 180d. 00m.
The Sum is the Sun's Right Aſcenſion —— 223d. 30m. from ♈.

Problem 4. *The Latitude of a Place, and the Sun's Declinatio given; to find the Sun's Amplitude, and Aſcenſional Difference.*

Definition 1. Latitude of a Place, or Latitude upon the Earth is an Arc of the Meridian of that Place, contained between th Zenith (of that Place) and the Equinoctial, as ZÆ; equal there unto is the Height of the Pole above the Horizon, as BP. *Plate* 7 *Figure* the 2d.

2. *Amplitude*, is an Arc of the Horizon, contained betwee the Ecliptic and the Equinoctial, and ſheweth how far the Su or any Star riſeth, or ſetteth from the Eaſt, or Weſt Points of th Horizon; as AR. *Plate* 7. *Figure* the 2d.

3. *Aſcenſional Difference*, is the Difference between the Righ Aſcenſion, and the Oblique Aſcenſion, or Deſcenſion: Or it an Arc of the Equinoctial, contained between the Hour Circle o ſix a Clock, and that Meridian which paſſeth through the *Sun* o *Star's* Center, or any Point of the Ecliptic, in their Riſing, or i their Setting.

4. *Oblique* { *Aſcenſion,* / *Deſcenſion,* } is an Arc of the Equinoctial cor tained between the Beginning of ♈, and that Part of the Equi noctial that { Riſeth / Setteth } with the Center of the *Sun* or *Star*, o with any Point, Part, or Portion of the *Ecliptic*, in an *Obliq Sphere.*

	d.	m.		*Example.*
Latitude	51	31	*North given; What is his*	Amplitude,
Sun's Dec.	23	29		Aſcenſ. Diff.

In the Rectangle Spheric Triangle PBR. *Plate* 7. *Fig* 2.

1. PBR the Rectangle.
2. PB the Latitude, or Height of the Pole above the Horizo
3. PR the Complement of the *Sun's* Declination.
4. BR the Complement of the *Sun's* Amplitude.
5. BPR the Complement of the *Sun's* Aſcenſional Difference.

To project it ſtereographically on the Plane of the Meridian.

1. The Primitive Circle being deſcribed and quartered (formerly) with two Right Circles SAB the Horizon, and (ZA the Prime Vertical; with A at its Center. *Plate* 7. *Fig.* the 2d.

2. On the *Primitive Circle* lay the Latitude 51d. 31m. from to P, and from Z to Æ, by Problem 6. Caſe 1. of *Spheric Geom try*, in Page 116 and draw the two Right Circles PAI for the Ax of the World, or Hour Circle of Six, and ÆAQ the Equinoctial

3. The

3. Then (by Problem 9. Caſe 2. of *Spheric Geometry*, in Page 121) draw ♋ ☉ l f R g parallel to ÆAQ, at 23d. 29m. (the given Declination) from it, to cut the Horizon SAB in R, the Place of the *Sun's* Riſing and Setting.

4. Through P, R, and I, draw an Oblique Circle, and it's done: For in the Rectangle Spheric Triangle PBR, the Leg BR, and Angle BPR are the two Things required, and may be meaſured by Problems 7 and 8, of *Spheric Geometry*, in Pages 117, 118, and 119.

But by Trigonometry, having the Hypotenuſe PR 66d. 31m. and Leg BP 51d. 31m. given, the Proportions by Chap 5. Section 4. Problem 1. Caſes 1 and 3. of *Spheric Trigonometry Rectangular*, in pages 135 and 136, are thus:

1. To find the Sun's Amplitude, the Proportion is,

As the Sine Complement of the Latitude, is to the Radius;
So is the Sine of the *Sun's* Declination to the Sine of the Sun's Amplitude. Or thus;
As S. c. Leg BP .. Radius : : S. c. Hyp. PR .. S. c. Leg BR.
As S. 38d. 29m. .. S. 90d. : : S. 23d. 29m. .. S. 39d. 49m.

Note; The Amplitude and Declination are ever of one Name; that is, both North, or both South.

2. To find the Aſcenſional Difference, the Proportion is;

As the Radius is to the Tangent of the Latitude;
So is the Tangent of the *Sun's* Declination, to the Sine of the *Sun's* Aſcenſional Difference. Or thus;
As Radius .. T. Leg BP : : T. c. Hyp. PR .. S. c. Angle BPR.
As T. 45d. .. T. 51d. 31m. : : T. 23d. 29m. .. S. 33d. 08m. the Sun's Aſcenſional Difference.

Problem 5. *The Latitude of a Place, and the Sun's Declination given; to find his Oblique Aſcenſion or Deſcenſion.*

The Rule. 1. Find the *Sun's* Right Aſcenſion by Problem 3. and the Aſcenſional Difference by Problem 4. Then,

2. When the Latitude and Declination are both North, or both South, the Aſcenſional Difference added to, and ſubſtracted from the Sun's Right Aſcenſion, the firſt is the Oblique Deſcenſion, the latter is the Oblique Aſcenſion.

3. When the Latitude and Declination are one North, and the other South, add and ſubſtract as before; the firſt is the Oblique Aſcenſion, and the latter is the Oblique Deſcenſion.

Note; When you cannot ſubſtract, add 360 Degrees to the Right Aſcenſion, and then ſubſtract; alſo when you have added, if the Sum exceeds 360 Degrees, ſubſtract 360 Degrees therefrom, the Remainder is the Thing required.

Example. Latit. 51d. 31m. North — — —— } given; what is
Sun's Declin. 15d. 40m. South decreaſing }
his Oblique Aſcenſion and Deſcenſion?

1. For the *Sun's Right Aſcenſion*, it's thus;
As Radius .. T.c.AngleMAC : : T.LegMC .. S. Leg AM:
AsT.45d. .. T.66d. 31m. : : T.15d.40m. .. S. 40d. 12m.
Which ſubſtracted from — — 360d. 00m.
Remainder is the Sun's Right Aſcenſion 319d. 48m. from ♈.

2. For his *Aſcenſional Difference*, it's thus;
AsRadius .. T. Latitude : : T. ☉ Declin. .. S. ☉ Aſcen. Diff.
AsT.45d. .. T.51d.31m. : : T. 15d. 40m. .. S. 20d. 39m.
Right Aſcenſion found above — — — 319d. 48m. from ♈.
Added is the Sun's Oblique Aſcenſion — 340d. 27m.
Subſtracted is the Sun's Oblique Deſcenſion 299d. 09m.

Problem 6. *The Latitude, and the Sun's Declination given; t find the Time of the* Sun's Riſing *and* Setting, *and the Lengt of the Day and Night?*

The Rule. 1. Find the Sun's Aſcenſional Difference by Problem 4, in pages 216 and 217, which is reduced into Time, b allowing as hereunder.

15d. 00m. } for { 1.---- Hour--- } of Time;
1d. 00m. } for { 0.04. Minutes } of Time;
0d. 15m. } for { 0.01. Minute } of Time;

2. The Sun's Aſcenſional Diffence (being reduced into Hour and Minutes) added to, and ſubſtracted from 6 Hours, the one i Sun-riſing, and the other is Sun-ſetting.

Note; When the Latitude and Declination are both North, o both South, the Sun riſeth before, and ſets after Six. But if on be North, and the other South, he then riſeth after, and ſets before Six of the Clock.

3. Double the Time of Sun-ſetting, gives the Length of th Day; alſo double the Time of Sun riſing, gives the Length the Night.

Example. Latitude 51d. 31m. North, Sun's Declination 23 29m. North given; the Sun's Aſcenſional Difference, by Problem 4, is 33d. 08m. equal in Time to 2 Hours, 12 Minutes, 3 Seconds. Therefore the Work is as follows.

h. ′ ″
d. m. 6.00 00
Aſc. Diff. = 33.08, or = 2.12.32 h. ′
Add, is Sun-ſetting = 8.12.32 } Len. of { Day is = 16.25.
Subſtr. is Sun-riſing = 3.47.28 } Len. of { Night is = 7.34.5

In the ſame Rectangle Spheric Triangle PBR (*Plate* 7. *Fig.* 2.) may the five next following Problems be reſolved; which are for he Learner's Exerciſe.

Problem 7. Latitude of a Place, and the Sun's Aſcenſional Difference given; to find his Declination, and Amplitude?

Example. The { Latitude —— —— 41d. : 47m. South.
Sun riſeth at ——— 7d. : 30m.

Here is a Leg, and its adjacent Angle given; that is, the Leg BP 41d. 47m. the Latitude, and the Angle BPR 4h. 30m. or 67d. 30m. the Complement of the Sun's Aſcenſional Difference; which Triangle is made by Problem 12. of Spheric Trigonometry Geometric, in Page 125; and for its Solution, ſee Chapter 5, Section 4, Problem 3, Caſes 8 and 9, of Spheric Trigonometry Rectangular, in Pages 137 and 138, and is thus;

1. For the Sun's Declination, it's thus;

As Radius .. S.⊙Aſcen.Diff. : : T.c.Latitude .. T. ⊙ Declin.
As S.90d... S. 22d. 30m. : : T.48d.13m... T. 23d. 11m. N.

2. For the Sun's Amplitude, it's thus;

As T. ⊙ Aſcen. Diff... Radius : : S. Latitude .. T.c. ⊙ Ampli. Or,
As S. Latitude .. Radius : : T.⊙ Aſcen.Diff... T. ⊙ Amplitude.
As 41d. 47m... S 90d. : : T. 22d. 30m. .. T. 31d. 52m. N.

Problem 8. Latitude, and Sun's Amplitude given; to find his Declination, and Aſcenſional Difference.

Example. The { Latitude ——— 36d. : 17m. North.
Sun's Amplitude 19d. : 11m. South.

Here are both the Legs given; that is, the Leg S I 36d. 17m. he Latitude, and the Leg SR 70d. 49m. the Complement of the Sun's Amplitude; which Triangle is made by Problem 14. of Spheric Trigonometry Geometric, in Page 127, and it's Solution s (by Chapter 5, Section 4, Problem 5, Caſes 13 and 14, of Spheric Trigonometry Rectangular, in pages 139 and 140,) in his Manner.

1. For the Sun's Declination, thus;

As Radius .. S.c.Latitude : : S. ⊙ Amplit. .. S. ⊙ Declinat. req.
As S. 90d. .. S. 53d. 43m. : : S. 19d. 11m. .. S. 15d. 21m. South.

2. For his Aſcenſional Difference, thus;

As T. c. ⊙ Am. .. Radius : : S. Latitude .. T. ⊙ Aſcen. Diff. Or,
As Radius .. S. Latitude : : T. ⊙ Amplit. .. T. ⊙ Aſcen. Differ.
As 90d. .. S. 36d.17m. : : T.19d.11m. .. T.11d. 38m. or 0h. 47m.

Problem 9. The Sun's Declination, and Amplitude given; to find the Latitude, and Sun's Aſcenſional Difference?

Example. The Sun's { Declination —— 19d. : 10m. South.
Amplitude —— 31d. : 30m. South.

Here is the Hypotenuſe, and one Leg given; for which ſ
Problem 10. *of Spheric Trigonometry Geometric*, (in *Page* 12
Chapter 5, *Section* 5, *Problem* 1, *Caſes* 2 and 3, of *Spheric Tr*
gonometry Rectangular, in pages 135 and 136) for its Solution.

Note; The Latitude may be either North, or South, in th
Problem.

Problem 10. Sun's Declination, and Aſcenſional Differen
given; to find the Latitude, and his Amplitude?

Example. The { Sun's Declination ——— 23^{d}. 29m. South
Sun ſetteth at —— —— — 3^{h}. 30m.

Here is the Hypotenuſe and one Angle given; for which ſee Pro
lem 11, of *Spheric Trigonometry Geometric*, (in *pages* 124, & 12
and Chapter 5, Section 4, Problem 2, Caſes 4 & 5, of *Spheric T*
gonometry Rectangular, in pages 136 and 137.) for its Solution.

Problem 11. Sun's Amplitude, and Aſcenſional Difference give
to find the Latitude, and his Declination?

Example. The { Sun's Amplitude ——— 33^{d}. 20m. North.
Sun ſetteth at —— —— — 7^{d}. 47m.

Here is one Leg, and it's oppoſite Angle given, for which
Problem 13, of *Spheric Trigonometry Geometric*, (in *page* 126, a
Chapter 5, Section 4, Problem 4, Caſes 10 and 12, of *Spheric T*
gonometry Rectangular, in *Pages* 138 and 139) for the Proportion

Problem 12. The Latitude of a Place, and the Sun's Declinati
given; to find his Altitude, and Azimuth at the Hour of Six?

Definition. 1. Altitude is an Arc of an Azimuth Circle, co
tained between the Horizon and any Parallel of Altitude; as t
Plate 7. *Fig.* 2.

2. *Azimuth*, is an Arc of the Horizon, contained between t
Meridian of the Place, and any Azimuth Circle; or contair
between the Prime Vertical, and any other Azimuth Circle;
A b. *Plate* 7. *Fig.* 2.

Example. The { Latitude ——— 51d. 31m. } North.
Sun's Declination — — 23d. 29m. }

Note; At Six of the Clock the Sun is upon the Axis PAI.

In the Rectangle Spheric Triangle A b f (*Plate* 7. *Fig.* 2.)
to be noted.

1. A b f the Rectangle.
2. b A f the Latitude of the Place.
3. A f the Sun's Declination, of the ſame Name with
Latitude.
4. b f the Sun's Altitude at the Hour of Six.

5.

5. A b the Sun's Azimuth from the Eaſt at 6 in the Morning, nd from the Weſt at 6 in the Afternoon; Northerly in North atitudes, but Southerly in South Latitudes.

To project it Stereographically, on the Plane of the Meridian.

1. Having deſcribed the Primitive Circle, quarter'd it, drawn he Axis of the World PAI, the Equinoctial ÆAQ, and the Parallel of Declination ♋ ☉ l f R g, as before directed in Problem .: of this Chapter, in pages 216 and 217.

2. Through f (where the Parallel of Declination cutteth the xis PAI) draw an Oblique Circle perpendicular to the Horizon AB (by Problem 5, Caſe 3. of *Spheric Geometry*, in pages 114 nd 115) as in the Azimuth Circle Z f b N, to cut SAB in b, which forms the Rectangle Triangle A b f, and it's done.

For the Leg A b, the Sun's Azimuth, and the Leg b f, the un's Altitude at 6 of the Clock, are the two things required, nd are meaſured by Problem 7, Caſes 2 and 3, of *Spheric Geometry*, in pages 117 and 118.

But by *Spheric Trigonometry*, having the Hypotenuſe and one ngle given, that is A f 23d. 29m. the Sun's Declination, and A f 51d. 31m. the Latitude; the Leg b f the Sun's Altitude, nd Leg A b his Azimuth at 6 of the Clock; are found by Chaper 5, Section 4, Problem 2, Caſes 4 and 5, of *Spheric Trigonometry Rectangular*, in pages 136 and 137.

1. To find the Sun's Altitude at 6, the Proportion is;

As the Radius, is to the Sine of the Latitude; ſo is the Sine of he Sun's Declination, to the Sine of the Sun's Altitude, at the lour of 6. Or thus;

s Radius .. S. Angle bAf : : S. Hypot. A f .. S. Leg b f.
s S. 90d. .. S. 51d. 31m. : : S. 23d. 29m. .. S. 18d. 11m.

2. To find the Sun's Azimuth, the Proportion by the aforeſaid roblem, is,

As the Radius, is to the Sine Complement of the Latitude; o is the Tangent of the Sun's Declination, to the Tangent of he Sun's Azimuth from the Eaſt or Weſt, at the Hour of 6. r thus;

s Radius .. S. c. Angle bAf : : T. Hypot A f. .. T. Leg A b.
s S. 90d. .. S. 38d. 29m. : : T. 23d. 29m. .. T. 15d. 08m.

That is,

At 6 in the Morning the Sun is E. 15d. 08m. N. or near upon he ENE. ¾ E. Point of the Compaſs; and at 6 in the Afternoon e is nearly upon the WNW. ¾ W. Point of the Compaſs.

In the ſame Triangle A b f (*Plate* 7. *Fig.* 2.) may be reſolved the five Problems next following, to exerciſe the young Learner.

Problem 13. The Latitude, and Sun's Altitude at the Hour of Six given; to find his Declination and Azimuth?

Example. The { Latitude —— 35d. 20m. South.
Sun's Altitude - 9d. 50m. P. M.

Here is one Leg and its oppoſite Angle given; that is, the Leg b f 9d. 50m. the Sun's Altitude, and the Angle b A f, 35d. 20m. the Latitude; which Triangle is made by Problem 13. of Spheric Trigonometry Geometric, in page 126; and for its Solution, ſee Chapter 5, Section 4, Problem 4, Caſes 10 and 12, in pages 138 and 139. And is thus;

1. For the Sun's Declination, the Proportion is,

As S. Latitude .. Radius : : S. ⊙ Alt. at 6 .. S. ⊙ Declination.
As S. 35d. 20m. .. S. 90d. : : S. 9d. 50m. .. S. 17d. 10m. South.

2. For the Sun's Azimuth at 6, the Proportion is,

As Radius .. T. c. Latitude : : T. ⊙ Alt. at 6 .. S. ⊙'s Azimuth.
As T. 45d. .. T. 54d. 40m. : : T. 9d. 50m. .. S. 14d. 9m. Weſt Southerly, or WSW. ¼ W. is the Point of the Compaſs the Sun is upon.

Problem 14. Latitude, and Sun's Azimuth at the Hour of 6 given; to find his Declination, and Altitude?

Example. The { Latitude —— 36d. 19m. North.
Sun's Azimuth 10d. 14m. W. Northerly.

Here is a Leg and its adjacent Angle given; that is, the Leg A b 10d. 14m. the Sun's Azimuth, and the Angle b A f 36d. 19m. the Latitude; which Triangle is made by Problem 12 of Spheric Trigonometry Geometric, in page 125, and for its Solution, ſee Chapter 5, Section 4, Problem 3, Caſes 7 and 9, in pages 137 and 138. Which is thus;

1. For the Sun's Declination, the Proportion is,

As T. ⊙ Azim. .. Radius : : S. c Latitude .. T. c. ⊙ Dec. Or,
As S. c. Latitude .. Radius : : T. ⊙ Azim. .. T. ⊙ Declination.
As S. 53d. 41m. .. S. 90d. : : T. 10d. 14m. .. T. 12d. 38m. N.

2. For the Sun's Altitude at 6, the Proportion is;

As T. c. Latitude .. Radius : : S. ⊙ Azim. .. T. ⊙ Altitude. Or,
As Radius .. S. ⊙ Azimuth : : T. Latitude .. T. ⊙ Altitude at 6.
As S. 90d. .. S. 10d. 14m. : : T. 36d. 19m. .. T. 7d. 26m. Alt. at 6.

Problem 15. *The Sun's* Declination, *and* Altitude *at the Hour of Six given; to find the* Latitude, *and his* Azimuth?

Example. The Sun's { Declination—21d. 30m. South.
Altitude—— 15d. 56m. A.M.

Here is the Hypotenuſe and one Leg given; that is, A f 21d. m. the Sun's Declination, and b f 15d. 56m. the Sun's Altitude; which ſee *Problem* 10, of *Spheric Trigonometry Geometric*, in ge 123, and Chapter 5, Section 4, Problem 1, Caſes 2 and 3, *Spheric Trigonometry Rectangular*, in pages 135 and 136.

oblem 16. Sun's Declination, and his Azimuth at the Hour of Six given; to find the Latitude, and his Altitude?

Example. The Sun's { Declination 19d. 14m. South
Azimuth — 10d. 09m. E. Southerly

Here is (as in the laſt Problem) the Hypotenuſe and one Leg en; that is, A f 19d. 14m. the Sun's Declination, and A b d. 09m. the Sun's Azimuth; for which ſee Problem 10, of *eric Trigonometry Geometric*, in page 123, and Chapter 5, tion 4, Problem 1, Caſes 1 and 3, of *Spheric Trigonometry ctangular*, in pages 135 and 136.

oblem 17. Sun's Azimuth, and Altitude at the Hour of Six given; to find the Latitude, and his Declination?

Example. The Sun's { Azimuth 16d. 10m. W. Southerly.
Altitude— 9d. 00m.

Here are both Legs given; for which ſee Problem 14, of *eric Trigonometry Geometric*, in page 127, and Chapter 5, tion 4, Problem 5, Caſes 13 and 14 of *Spheric Trigonometry. ctangular*, in pages 139 and 140.

oblem 18. The Latitude of a Place, and the Sun's Declination given; to find the Sun's Altitude, and the Hour of the Day when the Sun is Eaſt or Weſt.

Note; When the Sun is either Eaſt or Weſt, he is then upon Prime Vertical, Z A N. *Plate* 7. *Fig.* 2.

Example. The { Latitude ——— 51d. 31m.
Sun's Declination 23d. 29m. } North.

n the *Rectangle Spheric Triangle* A k l, *Plate* 7. *Fig.* 2. ſerve, That,

1. A k l is the Rectangle.
2. k A l the Latitude.
3. k l the Sun's Dec. of the ſame Name with the Lat.
4. A l the Sun's Altitude when he is upon the Eaſt or Weſt imuth Circle.
5. A k the Hour from 6; if Eaſt, after 6 in the Forenoon, when Weſt, before 6 in the Afternoon.

To project it *Stereographically* on the Plane of the Meridian.

1. The Primitive Circle being drawn, quartered, as alſo

the Axis PAI, Equinoctial ÆAQ, and Parallel of Declinatio ♋ ⊙ l f R g, as formerly, in Problem 4, of this Chapter, t cut the Prime Vertical ZAN in l, the Place of the Sun when h is either Eaſt or Weſt.

2. Then thro' l draw a Great Circle to cut the Equinocti ÆAQ at Right Angles in k, by Problem 5, Caſe 3, of *Spher Geometry*, in Page 115, as the Oblique Circle P l k I, whic forms the Rectangle Spheric Triangle A k l.

For the Hypotenuſe A l, and Leg A k (the former the Sun Altitude, the latter the Hour from 6, when he is either Eaſt Weſt) are the two Things required, and are meaſured by Prob lem 7, Caſe 2, of *Spheric Geometry*, in page 118.

But by *Trigonometry*, having a Leg and its oppoſite Angle give that is, k A l 51d. 31m. the Latitude, and k l, 23d. 29m. th Sun's Declination; the Leg A k the Hour from 6, and the Hy potenuſe A l, the Sun's Altitude when Eaſt, or Weſt, are four by Chapter 5, Section 4, Problem 4, Caſes 10 and 12 of *Spher Trigonometry*, in pages 138 and 139. Thus,

1. To find the Sun's Altitude, the Proportion is,

As the Sine of the Latitude, is to the Radius;

So is the Sine of the Sun's Declination, to the Sine of his A titude, when Eaſt, or Weſt. Or thus;

As S. Angle kAl .. Radius : : S. Leg k l .. S. Hypot. A l.

As S. 51d. 31m. .. S. 90d. : : S. 23d. 29m. .. S. 30d. 36m. ⊙ Alt

2. To find the Hour from Six, the Proportion by the aforeſa Problem 4, and Caſe 10, is,

As the Radius, is to the Tangent Complement of the Latitude

So is the Tangent of the Sun's Declination, to the Sine of t Hour from Six. Or thus;

As Radius .. T.c. AnglekAl : : T. Leg k l .. S. Leg A k.

As T. 45d. .. T. 38d. 29m. : : T. 23d. 29m. .. S. 20d. 12m. the Hour from Six.

Which reduced into Hours and Minutes of Time, and add to, and ſubſtracted from 6 Hours, giveth the Hour of the D required.

That is, 20d. 12m. reduced into Time, is 1h. 21m. almo

Which added to ———————— 6h. 00m.

The Sum ſheweth the Sun is Eaſt at ——— 7h. 21m. Mor

And being ſubtr. ſheweth the Sun is Weſt at 4h. 39m. After

In the ſame Rectangle Sheric Triangle A k l, (*Plate* 7. *Fig.* the five Problems following may be reſolved, and are here pr poſed to exerciſe the Learner.

Pro

Prob. XIX. The Sun Eaſt, the Latitude, and the *Sun*'s *Altitude* given; to find his Declination and the Hour of the Day?

Example. The { Latitude ——— 51d. 30m. North.
Sun's Altitude 25d. 16m. Morning.

Here is the Hypotenuſe, and one Angle given; that is, the Hypotenuſe Al 25d. 16m. the Sun's Altitude, and the Angle kAl 51d. 30m. the Latitude: Which Triangle is made by Problem 11. of *Spheric Trigonometry Geometric*, in page 124, and for ts Reſolution, ſee *Chapter* 5. *Section* 4. *Problem* 2. *Caſes* 4 and 5, in *pages* 136 and 137. And,

1. For the Sun's Declination, the Proportion is;
As Radius ·· S. Latitude : : S. ⊙ Altitude ·· S. ⊙ Declin. req.
As S. 90d. ·· S. 51d. 30m. : : S.c. 25d. 16m. ·· S. 19d. 30m. Nor.

2. For the Hour when he is Eaſt, the Proportion is,
As T.c. ⊙ Alt. ·· Rad. : : S.c.Lat. ·· T.Hour from 6, when E. Or,
As Radius ·· S c. Lat. : : T. ⊙ Alt. ·· T. Hour from 6, when E.
As 90d. ·· S. 38d. 30m. : : T. 25d. 16m. ·· T. 16d. 22m. or 1h. 5m.
which added to 6, makes 7h. 5m. the Time when the Sun is Eaſt.

Problem XX. The Sun Weſt, the *Latitude*, and Hour of the Day given; to find the Sun's *Altitude*, and *Declination*?

Example. The { Latitude — 30d. 10m. South.
Hour ——— 3h. 15m. P.M. or Afternoon.

Here is given a Leg, and its adjacent Angle; that is, the Leg Ak 41d. 15m. or 2h. 45m. the Hour from 6, when the un is Weſt; and the Angle kAl 30d. 10m. the Latitude; which Triangle is made by *Problem* 12. of *Spheric Trigonometry Geometric*. And for its Reſolution, ſee *Chapter* 5. *Section* 4. *Problem* . *Caſes* 7 and 9, in *pages* 137 and 138. And,

1. For the Sun's Declination, the Proportion is,
As T.c. Lat. ·· Rad. : : S. Hour from 6. ·· T. ⊙ Declination. Or,
As Radius ·· S. Hour from 6 : : T.Latitude ·· T.Sun's Declination.
As S. 90d. ·· S.41d. 15m. : : T. 30d. 10m. ·· T. 20d. 58m. South.

2. For the Sun's Altitude, the Proportion is,
As T.Hour from 6 ·· Rad. : : S.c.Lat. ·· T.c.⊙ Alt. when W. Or,
As S.c. Lat ·· Radius : : T. Hour from 6 ·· T. Sun's Alt. when W.
As S. 59d. 50m. ·· S. 90d. : : T. 41d. 15m. ·· T. 45d. 24m.
he Sun's Altitude, when Weſt.

Prob. XXI. The Sun Eaſt, his Declination, and his Altitude given; to find the Latitude, and the Hour of the Day?

Example. The Sun's { Declination 20d. 50m. South.
Altitude — 29d. 30m. A. M. or Morn.

Here

Here is given the Hypotenuſe, and one Leg; that is, t Hypotenuſe A l, 29d. 30m. the Sun's Altitude, and the L k l 20d. 50m. his Declination Which Triangle is made Problem 10. of *Spheric Trigonometry Geometric*, in page 122, a for its Reſolution, ſee Chapter 5. Section 4. Problem 1. Ca 2 and 3; in pages 135 and 136.

Prob. XXII. The Sun Weſt, his *Declination*, and Hour of t Day given; to find the *Latitude*, and his *Altitude*?

Example. The { Sun's Declination 10d. 39m. North.
Hour of the Day 4d. 52m. P. M.

Here are given both Legs; that is, the Leg k l 10d. 39 the Sun's Declination, and Leg A k 17d. or 1h. 8m. the Ho from 6, when the Sun is Weſt: For making this Triangle, Problem 14. of *Spheric Trigonometry Geometric* in page 127. A for its Reſolution ſee Chapter 5. Section 4. Problem 5. Ca 13 and 14, in pages 139 and 140.

Prob. XXII. The Sun Eaſt, his *Altitude*, and the Hour of t Day given; to find the *Latitude* and his *Declination*?

Example. The { Sun's Altitude ——— 30d. 10m.
Hour of the Day —— 7d. 50m. A. M.

Note; In this Problem the Latitude may be either North South, and both truly anſwer the Queſtion.

Here is given the Hypotenuſe, and one Leg; that is, t Hypotenuſe A l 30d. 10m. the Sun's Altitude when Eaſt, a the Leg A k 27d. 30m. or 1h. 50m. the Hour from 6, wh he is ſo; This Triangle is made by Problem 10. of *Spheric T gonometry Geometric*, in page 123, and for its Reſolution, Chapter 5. Section 4. Problem 1. Caſes 1 and 3, in pages 1 and 136.

Prob. XXIV. The Sun in the *Equinoctial*, the *Latitude* of Place, and the Sun's *Altitude* given; to find his *Azimuth*, a the Hour of the Day?

Note; When the Sun hath no Declination, he is then (ſaid be) in the Equinoctial; which is twice in a Year, about t 21ſt of *March*, and the 23d of *September*.

Examp

Example. The { *Latitude* —— 51d. 31m. *North.*
{ *Sun's Altitude* 21d. 50m. A.M.(or Morning.)

In the Rectangle Spheric Triangle Z Æ D, *Plate* 7. *Fig.* 2. t is to be noted;

1. The Angle Z Æ D the Rectangle.
2. The Leg Z Æ the Latitude of the Place.
3. The Leg Æ D the Hour of the Day from Noon.
4. The Leg ZD the Complement of the Sun's Altitude.
5. ÆZD the Sun's Azimuth from the South in North La- tude; but from the North in South Latitude, Eaſterly in the orenoon, and Weſterly in the Afternoon.

To project it Stereographically on the Plane of the Meridian.

1. The Primitive Circle being drawn, quartered, as alſo the xis P A I, and the Equinoctial A Æ Q as formerly directed in *roblem* 4. in *page* 216.

2. By *Problem* 9. *Caſe* 2. of *Spheric Geometry*, in *page* 121. raw a parallel Circle at 21d. 50m. (the given Altitude) diſtance om the Horizon S AB, as A D I t, to cut the Equinoctial A Q, in D; the Place of the Sun at that Time.

3. Through D (by *Problem* 5. *Caſe* 3. of *Spheric Geometry*, *page* 115) draw a great Circle perpendicular to SAB, as is the lique Circle Z D C N, which concludes the Rectangle Spheric iangle Z Æ D, and its done.

For the Angle Æ Z D, and Leg ÆD (the former the Sun's imuth from the South Meridian, the latter the Hour from on, when the Sun is in the Equinoctial) are the two things uired, and are meaſured by *Problem* 7. *Caſe* 2. and *Problem* 8. *ſe* 2. of *Spheric Geometry*, in *pages* 118 and 119.

But by Spheric Trigonometry, having the Hypotenuſe, and e Leg given; that is, ZD 78d. 10m. the Complement of the n's Altitude, and ZÆ 51d. 31m. the Latitude: The Angle ZD the Sun's Azimuth, and Leg ÆD the Hour from Noon, found by *Chapter* 5. *Section* 4. *Caſes* 1 and 2. of *Spheric gonometry Rectangular*, in *pages* 135 and 136. And,

1. To find the Sun's Azimuth, the Proportion is,
As the Radius, is to the Tangent of the Latitude;
So is the Tangent of the Sun's Altitude, to the Sine mplement of the Sun's Azimuth from the South: Or s;

As Radius ·· T. Leg ZÆ : · T. c. Hypot. ZD ·· S. c. Angle ÆZ
As T. 45d. ·· T. 51d. 31m. : : T. 21d. 50m. ·· S. 30d. 16m
Which ſubtract from ———————————————— 90d. 00m

Remainder is the Sun's Azimuth, South ———— 59d. 44m
Eaſterly, that is SE. by E. ¼ E. is the Point of the Compaſs t
Sun is upon.

2. To find the Hour, the Proportion by the foreſaid Proble
1. Caſe 3. is,

As the Sine Complement of the Latitude, is to the Radiu
So is the Sine of the Sun's Altitude, to the Sine Compleme
of the Hour from Noon. Or thus;

As S.c. Leg ZÆ ·· Radius : : S.c.Hypot.ZD ·· S. c. Leg ÆI
As S. 38d. 29m. ·· S. 90d. : : S. 21d. 50m. ·· S. 36d. 42m
Which ſubtract from ———————————— 90d. 00m

Remainder is the Hour from Noon ———— 53d. 18m

Which is equal to 3h. 33m. nearly, the Hour from Noo
therefore the Hour of the Day is 8h. 27m. in the Morning.

In the ſame Rectangle Spheric Triangle Z Æ D may five Pr
blems more be reſolved, which I leave for the Learner to inve
and ſo paſs on to *Oblique Spheric Triangles* in *Aſtronomy*.

Section III. *Oblique Spheric Triangles*, applied *in Aſtronon Problems*, uſeful in *Navigation*.

IN the laſt Section, Rectangular Spheric Triangles were appli
to *Problems* of *Aſtronomy*; now in like manner Oblique Sphe
Triangles ſhall be applied; both of them being very neceſſa
and uſeful in Navigation.

Problem I. *The Latitude of a Place, the* Sun's Declination, *a his* Altitude *given*; *to find his* Azimuth, *and the Hour of Day?*

Example. The { Latitude —— 51d. 30m. } Nor
Sun's { Declination —— 15d. 10m.
Altitude —— 11d. 30m.

In the Oblique Spheric Triangle PZ⊙. *Plate* 7. *Figure*
is to be noted.

1. The Side ZP the Complement of the Latitude.
2. The Side Z ⊙ the Complement of the Sun's Altitude.
3. The Side P ⊙ the Sun's Diſtance from the Elevated Po
which is the Declination added to 90 Degrees, when the La
tude and Declination are of a contrary Name; but if of o
Name, it's the Complement of the Declination.

4. T

he Angle PZ☉ the Sun's Azimuth from the North, in
atitude; but from the South, in South Latitude.
he Angle ZP☉ the Hour of the Day from Noon.
roject it *Stereographically* on the Plane of the Meridian.
aving drawn the Primitive Circle and quartered it, alſo
he Axis PAI, and the Equinoctial ÆAQ, and the Pa-
f Declination ☉ *lf* R *g*.
aw (by *Problem* 9. *Caſe* 2. of *Spheric Geometry*, in *Page*
parallel Circle, parallel to the Horizon S A B, at 11d.
he Sun's Altitude) diſtance from it, as *a l t*, to cut the pa-
Declination in ☉, the Place of the Sun at that time.
hen through ☉ draw two Great Circles, one through
N, the Poles of the Horizon; and the other through
the Poles of the Equinoctial; as are the Oblique Circles
nd P☉I; which form the Oblique Spheric Triangle
nd 'tis done.
Angles PZ☉, and ZP☉, the former the Sun's Azi-
e latter the Hour of the Day from Noon, are the two
quired, and are meaſured by *Problem* 8. *Caſe* 2. of
eometry, in *page* 119.
Spheric Trigonometry, having 3 Sides given; that is,
30m. the Complement of the Latitude, Z☉ 78d. 30m.
lement of the Sun's Altitude, and P☉ 74d. 50m. the
ance from the elevated Pole; the Angle P Z ☉ the
muth, and ZP☉ the Hour of the Day, are found by
Section 5. Problem 11. Caſe 11. of *Spheric Trigo-*
blique; in *pages* 147 and 148, as followeth.
the Complement of the Latitude, Complement of the
tude, and the Sun's Diſtance from the Elevated Pole
um.
n half that Sum ſubtract, (for finding the Sun's Azi-
e Sun's Diſtance from the Pole; but, for finding the
e Day, ſubtract the Complement of the Sun's Alti-
ng the half Sum, and the Remainder.
n to find the Sun's Azimuth, it's thus; to the Com-
rithmetic of the Sines of the Complement of the Lati-
Complement of the Sun's Altitude, add the Sines of
id Half-Sum, and Remainder; Half the Total of theſe
arithms, is the Sine of the Supplement of half the Sun's
from the North, in North Latitude; and from the
n South Latitude.

As Radius ·· T. Leg ZÆ : : T. c. Hypot. ZD ·· S. c. Ang
As T. 45d. ·· T. 51d. 31m. : : T. 21d. 50m. ·· S. 3c
Which ſubtract from ———————— 9c
Remainder is the Sun's Azimuth, South ———— 59
Eaſterly, that is SE. by E. ¼ E. is the Point of the Com
Sun is upon.

2. To find the Hour, the Proportion by the foreſaid 1. Caſe 3. is,

As the Sine Complement of the Latitude, is to th
So is the Sine of the Sun's Altitude, to the Sine Co
of the Hour from Noon. Or thus;
As S.c. Leg ZÆ ·· Radius : : S.c.Hypot.ZD ·· S.c. I
As S. 38d. 29m. ·· S. 90d. : : S. 21d. 50m. ·· S. 3(
Which ſubtract from ———————— 9(
Remainder is the Hour from Noon ———— 5

Which is equal to 3h. 33m. nearly, the Hour fro therefore the Hour of the Day is 8h. 27m. in the Mor

In the ſame Rectangle Spheric Triangle Z Æ D ma blems more be reſolved, which I leave for the Learner and ſo paſs on to *Oblique Spheric Triangles* in *Aſtronomy*.

Section III. *Oblique Spheric Triangles*, applied *in Problems*, uſeful in *Navigation.*

IN the laſt Section, Rectangular Spheric Triangles w to *Problems* of *Aſtronomy*; now in like manner Oblic Triangles ſhall be applied; both of them being ver and uſeful in Navigation.

Problem I. *The Latitude of a Place, the* Sun's Decli *his* Altitude *given*; *to find his* Azimuth, *and the I Day?*

Example. The { Latitude ——— 51d. 30
Sun's { Declination —— 15d. 10
Altitude ——— 11d. 30

In the Oblique Spheric Triangle PZ☉. *Plate* 7. is to be noted.

1. The Side ZP the Complement of the Latitude.
2. The Side Z ☉ the Complement of the Sun's Al
3. The Side P ☉ the Sun's Diſtance from the Elev which is the Declination added to 90 Degrees, when tude and Declination are of a contrary Name; but i Name, it's the Complement of the Declination.

4. The Angle PZ⊙ the Sun's Azimuth from the North, in North Latitude; but from the South, in South Latitude.

5. The Angle ZP⊙ the Hour of the Day from Noon.

To project it *Stereographically* on the Plane of the Meridian.

1. Having drawn the Primitive Circle and quartered it, alſo draw the Axis PAI, and the Equinoctial ÆAQ, and the Paallel of Declination ⊙ *lf*R*g*.

2. Draw (by *Problem* 9. *Caſe* 2. of *Spheric Geometry*, in *Page* 21.) a parallel Circle, parallel to the Horizon SAB, at 11d. 0m. (the Sun's Altitude) diſtance from it, as *alt*, to cut the paallel of Declination in ⊙, the Place of the Sun at that time.

3. Then through ⊙ draw two Great Circles, one through Z and N, the Poles of the Horizon; and the other through P and I the Poles of the Equinoctial; as are the Oblique Circles Z ⊙ N and P ⊙ I; which form the Oblique Spheric Triangle PZ⊙, and 'tis done.

For the Angles PZ⊙, and ZP⊙, the former the Sun's Azimuth, the latter the Hour of the Day from Noon, are the two hings required, and are meaſured by *Problem* 8. *Caſe* 2. of *pheric Geometry*, in *page* 119.

But by Spheric Trigonometry, having 3 Sides given; that is, P 38d. 30m. the Complement of the Latitude, Z⊙ 78d. 30m. he Complement of the Sun's Altitude, and P⊙ 74d. 50m. the un's Diſtance from the elevated Pole; the Angle PZ⊙ the un's Azimuth, and ZP⊙ the Hour of the Day, are found by hapter 5. Section 5. Problem 11. Caſe 11. of *Spheric Trigonometry Oblique*; in *pages* 147 and 148, as followeth.

1 Add the Complement of the Latitude, Complement of the un's Altitude, and the Sun's Diſtance from the Elevated Pole nto one Sum.

2. From half that Sum ſubtract, (for finding the Sun's Azimuth,) the Sun's Diſtance from the Pole; but, for finding the our of the Day, ſubtract the Complement of the Sun's Altiude, noting the half Sum, and the Remainder.

3. Then to find the Sun's Azimuth, it's thus; to the Comement Arithmetic of the Sines of the Complement of the Latide, and Complement of the Sun's Altitude, add the Sines of e aforeſaid Half-Sum, and Remainder; Half the Total of theſe ur Logarithms, is the Sine of the Supplement of half the Sun's zimuth from the North, in North Latitude; and from the outh, in South Latitude.

But to find the Hour of the Day it's thus; to the Complemen Arithmetic of the Sines of the Complement of the Latitude, an the Sun's Diſtance from the Pole, add the Sines of the ſaid hal Sum, and the Remainder; Half the Total of theſe four Logarithms, is the Sine of the Supplement of Half the Hour fron Noon, all which is ſhortened thus;

1. To find the Azimuth, the Operation is;

Side ZP 38d. 30m.	Containing Sides S.*co.ar.*—0.20585
Side Z⊙ 78d. 30m.	Containing Sides S.*co.ar.*—0.00880
Side P ⊙ 74d. 50m.	half Sum ſides 95d. 55m. S.—9.99768
Sum is 191d. 50m.	Remainder 21d. 05m. S.—9.55597
half Sum is 95d. 55m.	Sum of the 4 Logarithms is—19.768308
Remaind. 21d. 05m.	——— 49d. 59m. S.½ Sum 9.884154

Which doubled 49 59

The double is —— 99 58 Which

Subtract from —— 180 00

Remainder is the Sun's Azimuth 80 02 from the North.

Or by Gunter's Scale.

As Radius ·· S.c.Latitude, : : S. c. ⊙ Altitude ·· a 4th Sine.
As S. 90d. ·· S. 38d. 30m. : : S. 78d. 30m. ·· S. 37d. 35m.
Then again,
As the 4th Sine ·· S. ½ Sum ſides : : S. Remainder ·· a 5th Sine.
As S. 37d. 35m. ·· S. 95d. 55m. : : S. 21d. 05m. ·· S. 35d. 55m.

Againſt which, on the Line of Verſed Sines is 80d. 02m. the Sun's Azimuth from the North, Eaſterly if in the Morning, and from the North, Weſterly if in the Afternoon; that is, the Sun is near the E. by N. Point of the Compaſs in the Morning, and near the W. by N. Point in the Afternoon.

2. To find the Hour of the Day, the Operation is,

de {ZP 38d. 30m. ⊙P 74d. 50m. } Containing Sides { S. c. ar.—0.205850 / S. c. ar.—0.015397
Z⊙ 78d. 30m. | half Sum Sides 95d. 55m. S.—9.997680
ım is 191d. 50m. | Remainder 17d. 25m. S.—9.476133
ılf Sum is 95d. 55m. | Sum of the 4 Logarithms is 19.695060
emaind. 17d. 25m. | ————44.45 S. half Sum··9.847530
Which doubled————44.45
The double is ———— 89.30 Which
ſubtract from————180.00 h. m.
em. is the Hour from Noon —— 90.30 equal to 6 : 02.

Or by Gunter's-Scale.

s Radius ··S.c. Latitude : : S. ⊙ Diſt. from Pole ··a 4th Sine.
s. S. 90d. ··S 38d. 30m. : : S. 74d. 50m. ··S. 36d. 56m.

Then again,

s the 4th Sine ··S. $\frac{1}{2}$ Sum ſides : : S. Remainder ··a 5th Sine.
s S. 36d 56m. ··S. 95d. 55m. : : S. 17d. 25m. ··S. 29d. 42m.

Againſt which, on the Line of Verſed Sines, is 90d. 30m. 6h. 2m. the Hour from Noon; that is, 58m. after 5 in the orning, or 2m. after 6 in the Afternoon.

In the ſame Oblique Spheric Triangle ZP⊙, (*Plate* 7. *Fig.* 2.) ay the nine Problems next following be reſolved.

Problem II. *The* Latitude *of a Place, the Sun*'s Altitude, *and* zimuth *given*; *to find his* Declination, *and the Hour of the Day.*

xamp. *In* Latitude 51d. 32m. *the Sun being* 49d. 40m. *above the Horizon, his* Azimuth *was obſerved to be* North 119d. 44m. *Eaſterly, I demand the Hour of the Day, and the Sun*'s Decl.

Anſwer. The Hour of the Day is 29m. after 9, and the eclination of the Sun 23d. 28m. North.

In this Problem are two Sides, and one Angle between them ven; that is, ZP 38d. 28m. the Complement of the Latitude, ⊙ 40d. 20m. the Complement of the Sun's Altitude, and PZ⊙ 19d. 44m. his Azimuth; which Triangle is made by *Prob.* 18. *Spheric Trigonometry Geometric,* in *pages* 129 and 130. and is ſolved by *Problem* 9. *Caſes* 7 and 8. of *Spheric Trigonometry blique,* in *pages* 144 and 145.

rob. III. *The* Latitude *of a Place, the Sun*'s Declination and Azimuth *given*; *to find his* Altitude, *and Hour of the Day?*

xample. *In* Latitude 13d. 10m. *North, the Sun*'s Declination *being* 9d. 27m. S. *and his* Azimuth N. 120d. 30m. *Weſterly. I demand the Hour of the Day, and his* Altitude?

Anſwer. The Hour of the Day is 2h. 24m. in the Afternoon, nd the Sun's Altitude is 47d. 43m.

Here are two Sides, and one Angle oppoſite given; that is, Z P 76d. 50m. the Complement of the Latitude; P ⊙ 99d, 27m. the Sun's Diſtance from the Elevated Pole, and P Z ⊙ 120d. 30m. his Azimuth; which Triangle is made by Problem 16. of *Spheric Trigonometry Geometric*, in pages 128 and 129. And reſolved by Probelm 7. Caſes 2 and 3. of *Spheric Trigonometry Oblique*, in *Pages* 142 and 143.

Problem IV. The Latitude of a Place, Sun's Altitude. and the Hour of the Day given; to find the Sun's Azimuth, and his Declination.

Example. In Latitude 30d. 51m. South, at 15m. paſt 3 in the Afternoon, the Sun's Altitude being 41d. 10m. I demand the Sun's Azimuth, and Declination?

Anſwer. The Sun's Azimuth is South 102d. 4m. Weſterly, and his Declination 11d. 40m. South.

Here are two Sides, and one Angle oppoſite given.

That is, ZP 59d. 09m. the Complement of the Latitude; Z ⊙ 48d. 50m. the Complement of the Sun's Altitude, and Z P ⊙ 48d. 45m. Or 3h. 15m the Hour of the Day from Noon; and therefore projected, and reſolved like *Problem* 3. aforeſaid, in *Page* 231.

Problem V. The Latitude of a Place, the Sun's Declination, and Hour of the Day given; to find his Azmuth and Altitude?

Example. The Latitude 20d. 11m. North, the Sun's Declination 23d. 29m. South, at 9d. 24m. in the Morning: I demand the Sun's Azimuth, and what is his Altitude?

Anſwer. The Sun's Azimuth is South 44d. 13m. Eaſt, and his Altitude is 34d. 08m.

Here are two Sides and one Angle between them given; That is, ZP 69d. 49m. the Complement of the Latitude; P ⊙ 113d. 29m. the Sun's Diſtance from the Elevated Pole, and ZP ⊙ 39d. or 2h. 36m. the Hour of the Day from Noon, which is wrought as before in *Problem* 2. in *Page* 231.

Problem IV. The Latitude of a Place, the Sun's Azimuth, and Hour of the Day given; to find the Sun's Declination and Altitude.

Example. In Latitude 13d. 10m. North, the Sun's Azimuth being obſerved at 24m. after 2, to be South 59d. 30m. Weſt, I demand the Sun's Declination, and his Altitude?

Anſwer. The Sun's Declination is 9d. 27m. South, and his Altitude at the ſame time is 47d. 43m.

Here are two Angles, and one Side between them given; That is, ZP 76d. 50m. the Complement of the Latitude; PZ⊙ 120d. 30m. the Sun's Azimuth, and Z P ⊙ 36d. or 2h. 24m. the Hour of the Day from Noon; for the making of this Triangle, ſee *Problem* 19. of *Spheric Trigonometry Geometric*, in page 130. And is reſolved by Problem 10. Caſe 9. of *Spheric Trigonometry Oblique.* in pages 146.

Problem VII. The Sun's Altitude, Declination and his Azimuth given; to find the Latitude, and Hour of the Day.

Example. The Sun's Altitude being obſerved to be 38d. 20m. Oriental, his Azimuth at the ſame time was 107d. 10m. from the North, and his Declination 19d. 40m. N. I demand the Latitude of the Place of Obſervation, and the Hour of the Day?

Anſwer. The Latitude of the Place is 51d. 30m. North, and the Hour of the Day is 30m. after 8 in the Morning.

Here are two Sides, and one Angle oppoſite given; that is Z☉ 51d. 40m. the Complement of the Sun's Altitude; P☉ 70d. 20m. his Diſtance from the Elevated Hole, PZ☉ 107d. 10m. his Azimuth from the North, which Triangle is made and wrought as before, in *Problem* 3. of this *Section*, in *page* 232.

Problem VIII. The Sun's Altitude, his Declination, and Hour of the Day given; to find his is Azimuth, and the Latitude.

Example. At 5h. 42m. in the Morning, obſerving the Sun 12d. 30m. above the Horizon, and his Declination being 19d. 40m. North: I demand the Latitude of the Place, and the Sun's Azimuth?

Anſwer. The Latitude is 51d. 32m. North, and the Sun's Azimuth North 74d. 05m. Eaſterly, or ENE. half E. almoſt.

Here are two Sides, and one Angle oppoſite given; that is, Z ☉ 77d. 30m. the Complement of the Sun's Altitude; P ☉ 70d. 20m. his Diſtance from the Elevated Pole, and Z P ☉ 94d. 30m. or 6h. 18m. the Hour of the Day from Noon; which Triangle is made and wrought as before in Problem 3. of this Section, in page 232.

Problem IX. The Sun's Altitude, his Azimuth, and the Hour of the Day given; to find the Sun's Declination, and the Latitude of the Place?

Example. Obſerving the Sun 12d. 30m. above the Horizon at 18m. paſt 6 a Clock Afternoon, and his Azimuth 74d. from the North: I demand the Latitude and the Sun's Declination?

Anſwer. Latitude 51d. 30m. North, and Sun's Declination is 19d. 40m. North.

Here are two Angles and one Side oppoſite given; that is, Z ☉ 77d. 30m. the Complement of the Sun's Altitude; PZ☉, 74d. the Sun's Azimuth from the North, and ZP ☉ 94d. 30m. or 6h. 18m. the Hour from Noon; which Triangle is made by Problem 17. of *Spheric Trigonometry Geometric*, and is reſolved by Problem 8. Caſes 4 and 5. of *Spheric Trigonometry Oblique*, in pages 143 and 144.

Problem X. The Sun's Declination, his Azimuth, and Hour of the Day given; to find his Altitude and the Latitude of the Place.

Example. The Sun's Declination 19d. 40m. N. and at 28m. paſt 8 of the Clock in the Morning his Azimuth was obſerved to be 107d. 50m. from the North, I demand the Latitude of the Place of Obſervation, and what was the Sun's Altitude?

Anſwer. The Latitude is 51d. 30m. North, and the Sun's Altitude is 38d. 18m.

Here are two Angles and one Side oppoſite given, as before, in the laſt Problem: That is, P ⊙ 70d. 20m. the Sun's Diſtance from the elevated Pole, PZ⊙ 107d. 50m. his Azimuth from the North, and ZP⊙ 52d. Or 3h. 28m. the Hour of the Day from Noon; which Triangle is made and wrought by Problem 9. the laſt foregoing.

Prob. XI. The Latitude and Longitude of a Star, and the Obliquity of the Ecliptic given, to find the Right Aſcenſion, and the Declination of that Star?

Definition 1. Latitude of a Star, is an Arc of a Circle of Longitude, contained between the Star's Center and the Ecliptic.

2. Longitude of a Star, is an Arc of the Ecliptic, contained between the Beginning of *Aries*, and that Circle of Longitude which paſſeth over the Star's Center, and counted according to the Succeſſion of the Signs.

Example.

Capella, or the *Goat*, the { Latitude —— 22d. 52m. North.
{ Longitude —— 18d. 02m. in ♊.

In the Oblique Spheric Triangle PKD. *Plate* 7. *Fig.* 1. is to be noted.

1. PK the Diſtance of the Pole of the Ecliptic from the Pole of the World, equal to the Ecliptic's Obliquity 23d. 29m.

2. KD the Complement of the Star's Latitude, or its Diſtance from one Pole of the Ecliptic.

3. PD the Complement of the Star's Declination, or its Diſtance from the correſponding Pole of the World.

4. PKD the Star's Longitude from ♋, if the Star's Latitude be North, but from ♑, if it be South; that is, from ♋, if the Ecliptic's North Pole be one Angle; but from ♑ if its South Pole be one Angle of the Triangle.

3. KPD the Star's Right Aſcenſion from ♑, if its Latitude be North; but from ♋, if its Latitude be South: That is, if the Ecliptic's North Pole be one Angle, &c. as before in Note the 4th.

Here are two Sides, and one Angle between them given; That is, PK 23d. 29m. the Diſtance of the North Poles of the Equinoctial and Ecliptic, KD 67d. 08m. the Complement of the Star's Latitude, and PKD 11d. 58m. the Star's Longitude from (wanting of) *Cancer*; which Triangle is made by *Problem* 18. of *Spheric Trigonometry Geometric*, *Chapter* 5. *Section* 5. in pages 129 and 130. And by *Problem* 9. *Caſes* 7 and 8, in pages 144 and 145. the Proportions are as follows,

Firſt, To find the Star's Right Aſcenſion,	d.	m.
1. As S. half Sum of the Sides PK and KD	45	19
Is to S. half their Difference	21	50
So is T.c. of half the Angle PKD	84	01
To T. half Diff. of the Angles DPK and PDK	78	40
2. As S.c. half Sum of the Sides KD and KP	44	41
Is to S.c. half Difference	68	10
So is T.c. of half the Angle PKD	84	01
To T. half Sum of the Angles DPK and PDK	85	27
Unto which add their half Difference before found	78	40
And it giveth the Angle KPD	164	07
From which ſubtract AQ	90	00
Remainder is AM the Star's Right Aſcenſion from the Beginning of *Aries*.	74	07
Secondly, For the Star's Declination,	d.	m.
As S. KPD Star's Right Aſcenſion from *Capricorn*	164	07
Is to S. KD the Complement of its Latitude	67	08
So is S. PKD its Longitude from *Cancer*	11	58
To S. PD the Complement of the Star's Declination	44	15
Wherefore the Star's Declination is North	45	45

Problem XII. *The Right Aſcenſion of the Sun, and Right Aſcenſion of a Star given; to find the Time of the Star's coming to, or upon the Meridian.*

The Rule. Subtract the Sun's Right Aſcenſion from the Star's Right Aſcenſion, the Remainder reduced into Time, is the Time of the Star's coming upon, or to the Meridian, Afternoon.

Note; If you cannot ſubtract, add 360 Degrees to the Star's Right Aſcenſion, and then ſubtract.

Example. *The 5th of* October 1756; *I demand at what time* Aldebaran *or the* Bull's Eye, *cometh to the Meridian?*

The

d. m.

The { 16*th of* October, *the Sun's Declination is* 9 9 S. *increaſ.*
{ Latitude } *of* Aldebaran *is* { ——— 5 30 South.
{ Longitude } { ——— 5 58 in *Gemini.*

And therefore you may find that

By *Sect.* { 3. / 2. } *Prob.* { 3. / 11. } the { *Star's* / *Sun's* } *Right Aſc. is* { 65 13 / 201 15

Then add 360d. to 65d. 15m. the Star's Right Aſcenſion, and it is 425d. 15m. from which ſubtract 201d. 15m. the Sun's Right Aſcenſion, the Remainder is 224d. 00m. which maketh 14h. 56m. the Star's coming to the Meridian after Noon, that is 56m. after Two in the Morning.

And thus having found the Right Aſcenſion, Declination, and Time of any Star's coming upon the Meridian, you may by Problem 4. Section 2. of this Chapter, find its Amplitude, and Aſcenſional Difference, and thereby its Riſing and Setting; its Diſtance from the Meridian at any Altitude obſerved by, by Problem 1. Section 3. of this Chapter, in page 229, and ſo the Hour of the Night thereby; all which I leave for the Exerciſe of thoſe that are learning theſe Things.

Section IV. *The Doctrine of the* Sphere, *or* Spheric Trigonometry, *applied in ſundry* Aſtronomic Problems, *uſeful in* Navigation, *according to the* Pythagorean Syſtem.

THE *Pythagorean Syſtem of the World*, lately revived by *Copernicus*, is now generally received by the moſt, and beſt Aſtronomers; it being indeed moſt agreeable to the Motion of the Heavenly Bodies, confirmed by Experience in the conſtant Obſervation of them, in which are theſe Fundamental Principles.

1. That the Earth is carried round the Sun in a large Orb, or Path, betwixt the Orbs of the Planets *Mars* and *Venus*, once in a Year.

2. That beſides this Annual Motion, the Earth turns round her own Axis once in 24 Hours.

3. And that the ſaid Axis of the Earth, is inclined to the Plane of her Orb at the ſame Angle, and keeps in all Parts of it, nearly parallel to itſelf.

On theſe Aſſertions, but chiefly the Second, to wit, the Diurnal Motion of the Earth about its own Axis, once in 24 Hours, whereby all the viſible Appearances of the Sun, and

Plate 7.
Fig. II.

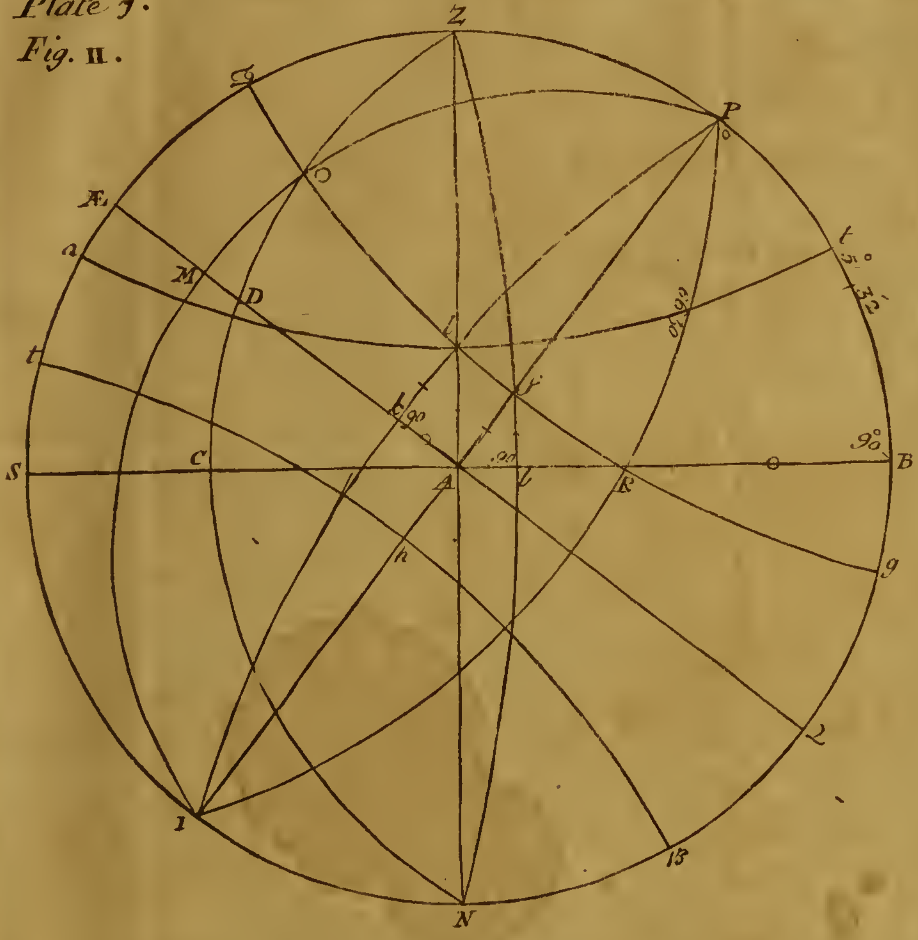
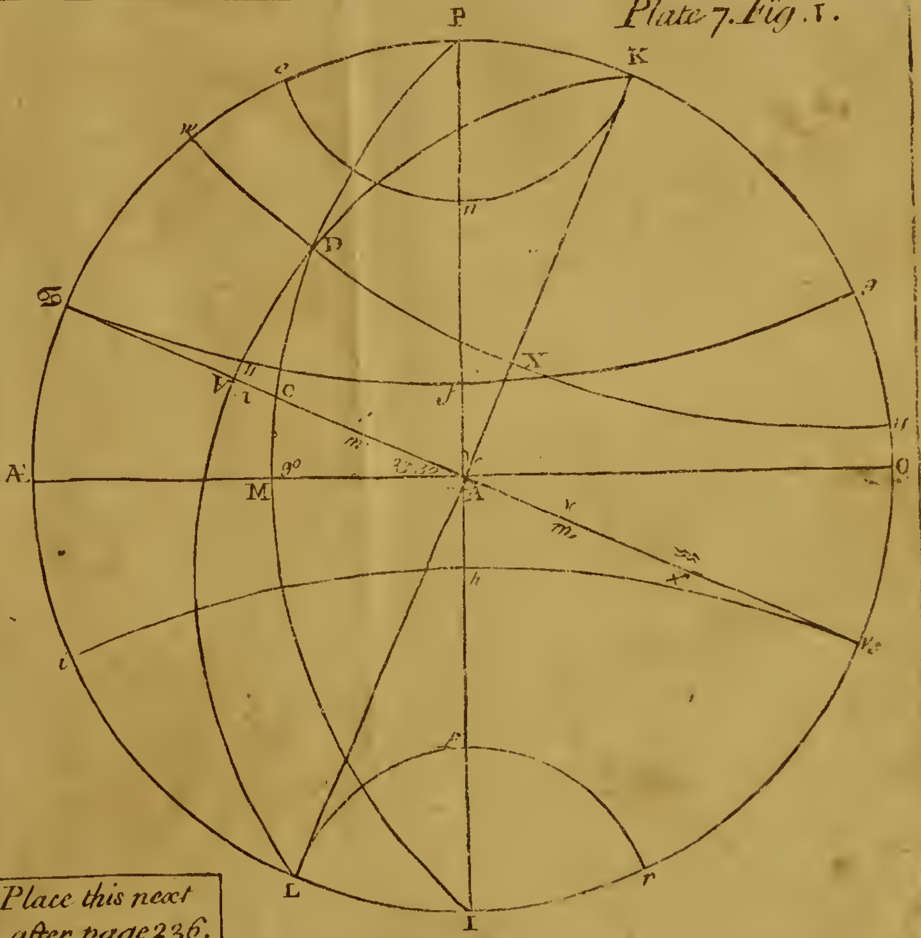


Plate 7. Fig. I.



Place this next
after page 236.

Fixed Stars are ſolved, I ſhall at preſent confine my Diſcourſe and on theſe the following Problems are grounded.

In order to a right underſtanding thereof, I will deſcribe the Circles of the Sphere, and how they are drawn in the *Stereographic Projection*, on the Plane of the Earth's Ecliptic, before I ſhew how to calculate any of its Requiſites.

Note, In the following Deſcription, I make uſe (for the moſt part) of the ſame Letters for the ſame Things, as before in the *Ptolomaic Projection*, treated of in this Chapter.

The Deſcription of the Circles of the Sphere (as grounded on the antient *Pythagorean*, or *Copernic Syſtem* of the World,) are as follow.

1. The Sun illuminateth one half of the Body of the Earth continually; as repreſented by *Plate* 8. *Figures* 1 and 2, wherein the Lines HKS, or HLS, which determine the Illuminate part of the Earth's Diſk A ☉ S, from the obſcure HDS; the ſaid HKS or HLS, is called the Horizon of the Earth's Diſk.

2. The Primitive Circle ♈ ♋ ♎ ♑ ♈, is the Earth's Ecliptic; which ever lieth in the Plane of the Ecliptic in the Heavens.

The Poles of the Ecliptic are K and L; the firſt is the North Pole of the Ecliptic, on the Earth's Globe, and the latter the South Pole thereof.

The Poles of the Earth's Globe are P and I; the firſt its North, and the latter its South Pole: Each being 23d. 29m. from its correſpondent Pole of the Ecliptic; that is KP, equal to LI, is equal to 23d. 29m. on the Scale of Half-Tangents, and is called the Line of Direction of the Earth's Axis.

3. The Equinoctial in the Heavens, or the Equator on the Earth, is repreſented by the Oblique Circle ♈ Q ♎, or ♈ Æ ♎, of which P and I are the Poles, and they are drawn with the Secant of 23d. 29m. according to *Problem* 2. *Caſe* 2. of *Spheric Geometry*, in *Pages* 112 and 113.

4. All Meridians paſs through the Poles of the Earth's Globe; as here ♈ P ♎, or ♈ I ♎, are Meridians, and drawn with the Secant of 66d. 31m. the Complement of 23d. 29m. as before.

♈ P ♎, or ♈ I ♎, is called the Firſt Meridian; and the Meridian ♋ PK ♑, or ♋ L I ♑ is the Earth's Solſtitial Colure: For whenever the direct Rays of the Sun run parallel to this Meridian, (and that is, when the Sun appears from the Earth, to be either in ♋ or ♑) then the longeſt and ſhorteſt Days are made in all Places on the Globe of the Earth.

The Earth's Equinoctial Colure, is ♈ K ♎, or ♈ L ♎, for whenever the Central Rays of the Sun run parallel to it, the Days and Nights are equal in all Places. Or, according to the *Ptolomic Syſtem*, the Meridian ♈ P ♎, and ♈ I ♎, is the Equinoctial Colure, tho' here we call it the firſt Meridian.

5. Circles of Longitude, paſs thro' the Poles of the Ecliptic, and in this Projection, are Right Circles; therefore are right Lines, as ♈ K ♎, ♋ K ♑, ☉ K D, *&c.*

Wherefore the Point in the Earth's Periphery, oppoſite to the Sun, or to a Star, or lying in a right or ſtreight Line produced from K or L, thro' the Center of the Sun, or any Star is called the Sun's or Star's place in the Ecliptic.

Theſe are the Great Circles belonging to this Projection: Now followeth,

The Deſcription of the Parallels or Leſs Circles.

6. Parallels of Declination, are here parallel to an Oblique Circle; the Equinoctial ♈ Q ♎, and ♈ Æ ♎, being ſuch.

The Tropic's are two parallels of Declination, diſtant from the Equinoctial 23d. 29m. or 66d. 31m. from each Pole of the World; as ♋ f g f ♋, and ♑ h i h ♑; the firſt is the Tropic of Cancer, the latter is the Tropic of Capricorn.

Theſe Tropics are thus drawn; from the Scale of Half-Tangents lay on the Soliſtitial Colure 46d. 58m. (the double of 23d. 29m.) from ♑ to g, or from ♋ to i. Or thus; lay the Half-Tangent of 43d. 02m. (the Complement of 46d. 58m.) from K to g, or from L to i: Then the middle between ♋ and g; or between ♑ and i, is the Center of theſe Tropics.

The Polar Circles are two Parallels of Declination, diſtant from the Equinoctial 66d. 31m. or 23d. 29m. from each Pole of the World as K n o n K, and L p r p L; the firſt is the Artic, the other the Antartic Circle.

They are thus drawn, on the Solſtitial Colure, lay the Half-Tangent of 46d. 58m. (the double of 23d. 29m.) from K to o, or from L to r; then the middle between K and o, or between L and r, is the Center of thoſe Polar Circles.

7. Parallels of Latitude, with reſpect to the Heavens, are in this Projection, parallel to the primitive Circle, which here is the Ecliptic: as any Circle drawn on K or L as a Center, is a parallel of Latitude.

All theſe Circles are General, as belonging to this Projection, without having regard to the Latitude of any particular Place on the Globe of the Earth. The Deſcription of the Meridians or Hour Circles, Azimuths and Parallels of Latitude; alſo how to draw them, (theſe being peculiar to a particular Latitude) you ſhall have in their proper Place, as they come in Uſe in the following Problems.

Problem I. *The Sun's Place in the Ecliptic given; to find his Diſtance from the North or South Pole of the Globe; his Right Aſcenſion; and the Angle which the Meridian paſſing through it, makes with the Ecliptic.*

Example. *The Sun's Place being in the Beginning of* Gemini, *or* 60 *Degrees from the firſt Point of* Aries; *I demand his Diſtance from the Pole,* &c.?

1. To do this, lay the Sun's Longitude 60d. on the Primitive Circle, from ♈ to ☉.

2. Through ☉ and P, or ☉ and I, draw a Great Circle ☉PD, or ☉ID, which is the proper Meridian, to the Place of he Sun.

3. Then, between the proper Meridian, the Ecliptic, and the olſtitial Colure, there is formed a Rectangle Spheric Triangle, aving its Legs given; to find the Hypotenuſe, and two Angles; That is,

In the Rectangle Spheric Triangle P ♋ ☉, or I ♋ ☉, *Plate* 8. *igures* 1 and 2.

1. The Leg ☉ ♋, is the Complement of the Sun's Longitude rom ♈, or his Diſtance from ♋, 30d.

2. The Leg ♋ P, or ♋ I, the Diſtance of the Pole of the lobe from the Ecliptic; or the Complement of the Diſtance of e Poles of the Globe and Ecliptic 66d. 31m.

3. The Hypotenuſe P ☉, or I ☉, the Sun's Diſtance from e North, or South Pole of the Globe.

4. The Angle ♋ P ☉, or ♋ I ☉, the Complement of the un's Right Aſcenſion, from the neareſt Equinoctial Point.

5. The Angle P ☉ ♋, or I ☉ ♋, the Angle of the proper eridian with the Ecliptic.

1. For the Sun's Diſtance from the Pole, the Proportion by *hapter* 5. *Section* 4. *Problem* 5. *Caſe* 14. of *Spheric Trigonometry Rectangular*, in *Pages* 139 and 140, is thus,

s Radius ·· S.c.Leg♋☉ : : S.c. Leg ♋P ·· S. c. Hypotenuſe P☉.
s S. 90d. ·· S. 60 deg. : : S. 23d. 29m. ·· S. 20d. 11m. the
eflection. That is,

As the Radius, is to the Sine of the Sun's Longitude from the quinoctial Point ♈.

So is the Sine of the two Poles Diſtance, to the Sine Complement of the Sun's Diſtance from the neareſt Pole of the Globe, or to the Sine of P B, or I B, the Reflection, which is equal t to the Sun's Declination in the *Ptolomaic Syſtem:* In this Caſ 20d. 11m. North.

2. For the Sun's Right Aſcenſion, the Proportion is,

As Radius ·· S. Leg P ♋ : : T. c. Leg ☉ ♋ ·· T. c. Angle ♋ P ☉

As S. 90d. ·· S.66d.31m. : : T. 60d. ·· T. 57d. 50m. Sun's Righ Aſcenſion. That is,

As the Radius, is to the Sine Complement of the two Pole Diſtance;

So is the Tangent of the Sun's Longitude, from the neareſ Equinox, to the Tangent of his Right Aſcenſion from the ſai Equinox.

3. For the Angle of the proper Meridian with the Ecliptic the Proportion is,

As Radius ·· S.Leg ♋ ☉ : : T.c. Leg ♋ P ·· T.c. Angle P ☉ ♋

As S. 90d. ·· S. 30d. : : T. 23d. 29m. ·· T. 12d. 15m.

Which ſubtract from ———————— 90d. 20m.

The Remainder being ———— ———— 77d. 45m. is th Angle of the Meridian and the Ecliptic.

In the ſame Rectangle Spheric Triangle, may Problem 2 an 3. of Section 2. of this Chapter be reſolved, which I paſs over.

Prob. II. The Latitude of a Place on the Globe of the Eart and the Sun's Place in the Ecliptic given; to find his Ampl tude and Aſcenſional Difference, and conſequently his Riſin and Setting.

Example. The Latitude 51d. 32m. North, Sun's Place 00d. i *Gemini* given; what's the Sun's Amplitude, and Aſcenſion Difference?

1. To do this, after you have done what was directed i Problem 1. Then get the Sum and Difference of the Latitude Complement, and the Diſtance of the two Poles, that is, th Sum, and Difference of 38d. 28m. and 23d. 29m. the firſt 61d. 57m. and the latter is 14d. 59m.

2. Then make Kt, or Lt equal to the Half Tangent of 61 57m. and alſo Km, or Lm equal to 14d. 59m. from the ſame Scal

3. The middle between m and t, is the Center of the Circ *a b c z t d e h m*, which is the parallel of Latitude for 51d. 32m and in this Projection, it's the Line deſcribed by *London*, as th Earth runs round, and from thence is called the Path of the Verte

An

And if you conceive the Colures, all the Meridians, the Path, of any Vertex, and indeed all the Lines and Circles that are, or ſhall hereafter be deſcribed, as a *fixed Rete*, cloſely inveſting the Earth, while ſhe turns round within it, whoſe Motion about its Axis being from Weſt to Eaſt; then the Sun is ſaid to Riſe, when the Vertex paſſeth that Point in that Path where it cuts the Horizon of the Earth's Diſk, which is here at *a*; To culminate or to be on the Meridian, where it croſſeth the proper Meridian betwixt him and the Pole, which here is at *z*; and to Set where the Vertex paſſeth the other Interſection of the Path and Horizon, as here at *h*.

4. Thro' *a* and ⊙, draw a Great Circle, as alſo thro' *a* and P; ſo have you two Triangles, on the Eaſt-ſide of the Meridian; to wit, ⊙ P *a*, and P B *a*; in like Manner if you draw Great Circles thro' P and *h*; and thro' ⊙ and *h*; they will form two Triangles on the Weſt, or deſcending Side of the Meridian: But any of theſe four Triangles may ſerve to anſwer the Problem, and therefore I take one Triangle at Sun-riſing, which may ſuffice for Sun-ſetting; wherein obſerve,

In the Rectangle Spheric Triangle P B *a*. *Plate* 8. *Fig.* 1.

1. The Leg PB the Reflection, or that which is equal to the Sun's Declination, found by Problem 1, in page 239, to be 20d. 11m. North.

2. The Hypotenuſe P *a*, the Complement of the Latitude of he Place, or the Diſtance of the Pole from the Vertex, in this Example 38d. 28m.

3. The Angle *B a* P the Amplitude, or the Complement of the Sun's Azimuth, from the North in North Latitude; and from the South, in South Latitude; for the Angle P *a* ⊙ is the Azimuth from the North at Sun-riſing, and the Angle B *a* P is its Complement, and therefore equal to the Sun's Amplitude.

4. The Angle B P *a*, the Hour from Midnight; that is, the Time of the Sun's Riſing after, and Setting before 12 at Night.

1. For the Angle at B *a* P, the Sun's Amplitude; the Proportion by Chapter 5, Section 4, Problem 1, Caſe 2, in pages 135 and 136, is;

As S. Hypotenuſe P *a* .. Radius : : S. Leg B P. .. S. Angle B *a* P.
As S. 38d. 28m. .. S. 90d. : : S. 20d. 11m. .. S. 33d. 42m.

That is,

As the Sine Complement of the Latitude, is to the Radius; So s the Sine of the Reflection, to the Sine of the Sun's Amplitude, 33d. 42m. from the Eaſt Northerly, at Sun-riſing; and from the Weſt Northerly, at Sun-ſetting.

2. For the Angle B P *a*, the Complement of the Aſcenſional Difference, the Proportion by the aforeſaid Problem 1, Caſe 1, in Page 135, is thus;

As Radius ·· T.c.Hypot.. P *a* : : T. Leg BP ·· S. c. Angle BP*a*.
As T.45d. ·· T. 51d. 32m. : : T. 20d. 11m. ·· S 27d. 34m.

the Sun's Aſcenſional Difference, which is equal to 1h. 50m. the Time the Sun riſeth before 6; and as much after 6, is the Sun's Setting, becauſe the Latitude is North, and the Sun in a Northern Sign; but it's the contrary, when one is North, and the other South.

In this Triangle may Problems 4, 5, 6, 7, 8, 9, 10, and 11. of Section 2. of this Chapter be reſolved.

Problem 3. The ſame given as before in Problem 2, to find the Sun's Diſtance from the Vertex, when due Eaſt or Weſt, and the Time from Noon when he ſhall be ſo. *Plate* 8. *Fig.* 1.

Example.

Latitude——51d. 32m. N. } *given; The* { *Sun's Zenith Diſtance.*
Sun's Place 00d. 00m. in ♊ } { *Time when he is Eaſt, or Weſt, required?*

1. To delineate this, after the proper Meridian, and Path of the Vertex, or parallel of Latitude is drawn, as before in Problems 1 and 2. Then thro' ⊙ and D, draw a Great Circle, juſt to touch the Path of the Vertex, on either ſide of it, as the Oblique Circle ⊙ *c* D, and ⊙ *d* D.

2. Through P and *c*, or P and *d*, draw a Great Circle, to cut ⊙ *c d*, ⊙ *d* D at Right Angles, which is the Place of the Vertex, when the Sun ſhall appear due Eaſt or Weſt: And then are formed two Triangles P *c* ⊙, and P *d* ⊙; one when the Sun is Eaſt, and the other when he is Weſt; in each the ſame things are given and required: Therefore obſerve,

In the Rectangle Spheric Triangle, P *c* ⊙. *Plate* 8. *Fig.* 1.

1. The Hypotenuſe P ⊙ the Sun's Diſtance from the Pole, found by Problem 1. to be 69d. 49m. the Complement of the Reflection.

2. The Leg P *c*, the Diſtance of the Pole from the Vertex, or Complement of the Latitude, in this Example 38d. 28m.

3. The Leg ⊙ *c*, the Sun's Diſtance from the Vertex, or Complement of his Altitude when Eaſt; And the ſame when Weſt.

4. The Angle ⊙ P *c*, the Hour from Noon, when he is, or ſhall appear to be Eaſt, or Weſt.

1. For the Leg ⊙ *c*, the Sun's Zenith Diſtance, the Proportion, by Chapter 5, Section 4. Problem 1, Caſe 3, in Pages 135 and 136, is,

As

S.c. Leg P c. ·· Radius : : S.c. Hypot. ⊙ P ·· S. c. Leg ⊙ c.
S. 51d. 32m. ·· S. 90d. : : S. 20d. 11m. ·· S. 26d. 09m.
's Altitude when Eaſt, and the ſame when Weſt.

That is,

s the Sine of the Latitude is to the Radius;
o is the Sine of the Reflection, to the Sine Complement of the
's Zenith Diſtance: or his Diſtance from the Vertex, in this
: 63d. 51m.

. For the Angle ⊙ P c, the Hour from Noon, the Propor-
is;

adius ·· T. Leg P c : : T.c. Hypot. P ⊙ ·· S. c. Angle ⊙ P c.
.45d. ·· T. 38d. 28m. : : T. 20d. 11m. ·· S. 16d. 59m. or
8m.

That is,

the Radius, is to the Tangent Complement of the Latitude;
is the Tangent of the Reflection, to the Sine Complement
e Hour from Noon, when the Sun is due Eaſt, or Weſt;
Sun is Eaſt at 8m. after 7 of the Clock in the Forenoon,
Weſt at 52m. after 4 in the Afternoon.

this Triangle may Problems 18, 19, 20, 21, 22, and 23,
ction 2. of this Chapter be reſolved.

roblem 4. The ſame given as before in Problem 2. to find the
un's Diſtance from the Vertex; and his Azimuth at the Hour
6. *Plate* 8. *Fig.* 1.

Example.

: { Latitude 51d. 32m. N. } given; the Sun's { Zen. Diſt.
{ Sun's Place 0 00 in ♊ } { Azimuth.
: 6 of the Clock is required?

. To delineate this; after the proper Meridian, and Path of Vertex are drawn, as before in Problem 2. Then thro' P, a Great Circle at Right Angles, with the proper Meridian, ut the Path in *b*, and in *e*, and the Horizon of the Earth's in A, where it always interſects the Equator, as the Ob- Circle A *b* P *e*, or A *b* I *e*, which is the Meridian or Hour- le of Six, ſo that *b* (in the Path) is the Place of the Vertex in the Morning; and *e* its Place at Six Afternoon.

. Therefore thro' ⊙ and *b*, or ⊙ and *e*, draw a Great le, and you will form two Right Angled Spheric Triangles , or *e*P⊙: One of them is ſufficient to ſolve the Queſtion, g equal Triangles: If you take the firſt at Six in the Morn- ; It follows;

the Right Angled Triangle *b* P ⊙. *Plate* 8. *Fig.* 1.

. The Leg P *b*, the Diſtance of the Pole from the Vertex;

2. For the Angle B P *a*, the Complement of the Aſcenſio Difference, the Proportion by the aforeſaid Problem 1, Caſ in Page 135, is thus;

As Radius .. T.c.Hypot.. P *a* : : T. Leg BP .. S. c. Angle E
As T.45d. .. T. 51d. 32m. : : T. 20d. 11m. .. S 27d. 34m.

the Sun's Aſcenſional Difference, which is equal to 1h. 50m. Time the Sun riſeth before 6; and as much after 6, is the S Setting, becauſe the Latitude is North, and the Sun in a Nort Sign; but it's the contrary, when one is North, and the o South.

In this Triangle may Problems 4, 5, 6, 7, 8, 9, 10, and of Section 2. of this Chapter be reſolved.

Problem 3. The ſame given as before in Problem 2, to fin Sun's Diſtance from the Vertex, when due Eaſt or Weſt, the Time from Noon when he ſhall be ſo. *Plate* 8. *Fig.* 1

Example.

Latitude——51d. 32m. N. } *given; The* { *Sun's Zenith Diſ*
Sun's Place 00d. 00m. in ♊ } { *Time when he is E*
or Weſt, required?

1. To delineate this, after the proper Meridian, and Pat the Vertex, or parallel of Latitude is drawn, as before in Probl 1 and 2. Then thro' ⊙ and D, draw a Great Circle, juſ touch the Path of the Vertex, on either ſide of it, as the Obli Circle ⊙ *c* D, and ⊙ *d* D.

2. Through P and *c*, or P and *d*, draw a Great Circle, to ⊙ *c d*, ⊙ *d* D at Right Angles, which is the Place of the Vert when the Sun ſhall appear due Eaſt or Weſt: And then are fo ed two Triangles P *c* ⊙, and P *d* ⊙; one when the Sun is E and the other when he is Weſt; in each the ſame things given and required: Therefore obſerve,

In the Rectangle Spheric Triangle, P *c* ⊙. *Plate* 8. *Fig.*

1. The Hypotenuſe P ⊙ the Sun's Diſtance from the P found by Problem 1. to be 69d. 49m. the Complement of Reflection.

2. The Leg P *c*, the Diſtance of the Pole from the Vertex, Complement of the Latitude, in this Example 38d. 28m.

3. The Leg ⊙ *c*, the Sun's Diſtance from the Vertex, or Co plement of his Altitude when Eaſt; And the ſame when Weſt.

4. The Angle ⊙ P *c*, the Hour from Noon, when he is, ſhall appear to be Eaſt, or Weſt.

1. For the Leg ⊙ *c*, the Sun's Zenith Diſtance, the Propo tion, by Chapter 5, Section 4. Problem 1, Caſe 3, in Pag 135 and 136, is,

As S.c. Leg P c. ·· Radius : : S.c. Hypot. ⊙ P ·· S. c. Leg ⊙ c.
As S. 51d. 32m. ·· S. 90d. : : S. 20d. 11m. ·· S. 26d. 09m.
Sun's Altitude when Eaſt, and the ſame when Weſt.

That is,

As the Sine of the Latitude is to the Radius;

So is the Sine of the Reflection, to the Sine Complement of the Sun's Zenith Diſtance: or his Diſtance from the Vertex, in this Caſe 63d. 51m.

2. For the Angle ⊙ P c, the Hour from Noon, the Proportion is;

As Radius ·· T. Leg P c : : T.c. Hypot. P⊙ ·· S. c. Angle ⊙Pc.
As T. 45d. ·· T. 38d. 28m. : : T. 20d. 11m. ·· S. 16d. 59m. or 1h. 8m.

That is,

As the Radius, is to the Tangent Complement of the Latitude;
So is the Tangent of the Reflection, to the Sine Complement of the Hour from Noon, when the Sun is due Eaſt, or Weſt; The Sun is Eaſt at 8m. after 7 of the Clock in the Forenoon, and Weſt at 52m. after 4 in the Afternoon.

In this Triangle may Problems 18, 19, 20, 21, 22, and 23, of Section 2. of this Chapter be reſolved.

Problem 4. The ſame given as before in Problem 2. to find the Sun's Diſtance from the Vertex; and his Azimuth at the Hour of 6. *Plate* 8. *Fig.* 1.

Example.

$$\text{he}\left\{\begin{array}{l}\text{Latitude 51d. 32m. N.}\\ \text{Sun's Place 0 00 in ♊}\end{array}\right\}\text{given; the Sun's}\left\{\begin{array}{l}\text{Zen. Diſt.}\\ \text{Azimuth.}\end{array}\right.$$

at 6 of the Clock is required?

1. To delineate this; after the proper Meridian, and Path of ie Vertex are drawn, as before in Problem 2. Then thro' P, aw a Great Circle at Right Angles, with the proper Meridian, cut the Path in *b*, and in *e*, and the Horizon of the Earth's iſk in A, where it always interſects the Equator, as the Obque Circle A *b* P *e*, or A *b* I *e*, which is the Meridian or Hourircle of Six, ſo that *b* (in the Path) is the Place of the Vertex 6 in the Morning; and *e* its Place at Six Afternoon.

2. Therefore thro' ⊙ and *b*, or ⊙ and *e*, draw a Great ircle, and you will form two Right Angled Spheric Triangles ⊙, or *e*P⊙: One of them is ſufficient to ſolve the Queſtion, ing equal Triangles: If you take the firſt at Six in the Morng; It follows;

In the Right Angled Triangle *b* P ⊙. *Plate* 8. *Fig.* 1.

1. The Leg P *b*, the Diſtance of the Pole from the Vertex;

or the Complement of the Latitude, in this Example 38d. 28m.

2. The Leg P ☉, the Sun's Diſtance from the Pole, found by Problem, 1, to be 69d. 49m. the Complement of the Reflection.

3. The Hypotenuſe *b* ☉, the Sun's Diſtance from the Vertex, or Complement of his Altitude at the Hour of 6.

4. The Angle P *b* ☉, his Azimuth from the North, in al North Latitudes, and the contrary in South Latitudes: For in what part of the Path ſoever the Vertex is found, that part o the Hour Circle, intercepted betwixt it and the North Pole of th Globe, is the North part of that Meridian, or Hour Circle; an intercepted betwixt it and the South Pole, is the South part o the Meridian.

5. For the Hypotenuſe *b* ☉, the Sun's Diſtance from the Ver tex at the Hour of 6, the Proportion (by Chapter 5, Section 4 Problem 5, Caſe 14, in pages 139 and 140.) is;

Radius .. S c. Leg P *b* : : S. c. Leg P ☉ .. Hypot. *b* ☉.
S. 90d. .. S. 51d 32m. : : S. 20d. 11m. .. S. 15d. 40m. the Sun Altitude at 6 in the Morning, or at 6 in the Afternoon.

That is;

As the Radius, is the Sine of the Latitude;

So is the Sine of the Reflection, to the Sine of the Sun Altitude, or Complement of his Diſtance from the Vertex, the Hour of 6, equal to 74d. 20m.

2. For the Angle P *b* ☉, his Azimuth at 6, the Proportic is;

As Radius .. S. Leg P *b* : : T. c. Leg P ☉ .. T. c. Angle P *b*
As S. 90d. .. S. 38d. 28m. : : T. 20d. 11m. .. T. 12d. 52m. Sun Azimuth from the Eaſt, at 6 in the Morning; but from t Weſt, at 6 in the Afternoon.

That is;

As the Radius, is to the Sine Complement of the Latitud

So is the Tangent of the Reflection, to the Tangent Co plement of the Sun's Azimuth from the Meridian, at the Ho of 6, equal to 77d. 8m. from the North; that is almoſt by N. at 6 in the Morning, and near W. by N. at 6 in t Afternoon.

In this Triangle may Problems 12, 13, 14, 15, 16 and of Section 2. of this Chapter be reſolved

Prob. 5. The Sun in the Equinoctial, the Latitude of a Pla and his Altitude given, to find his Azimuth, and Hour of the D.

Note; The Sun is ſaid to be in the Equinoctial, when he is the beginning of ♈, or ♎; and then he hath no Declination.

I

$$\textit{Ex. The}\left\{\begin{array}{l}\textit{Latitude}\ \ 51\text{d. }34\text{m. N.}\\ \odot\ \textit{Altitude}\ 33\text{d. }0\text{m. AM.}\end{array}\right\}\textit{given: The}\left\{\begin{array}{l}\textit{Sun's Azimnth}\\ \textit{Hour of the Day}\end{array}\right.$$

Required? To delineate this, *Plate* 8. *Figure* 1.

1. The Sun in the Beginning of ♈, then the Horizon of the Earth's Diſk is ♋ P K ♑, and the proper Meridian, then is ♈ P ♎; the Sun's Riſing at *London* is at *m*, his Setting at *t*, *&c.* The Path of the Vertex being drawn as before in Problem 2.

2. Then (by *Problem* 9, *Caſe* 2, of Spheric Geometry, in page 121) draw a parallel Circle at 57d. diſtance from *Aries*, to cut the path in *b*, the place of the Vertex of *London*, when its diſtance from the Sun is 57d. the Complement of the Sun's Altitude.

3. Draw a Meridian through P and *b*, and a Great Circle through *b* and ♈, the place of the Sun, ſo will you form the Triangle ♈ P *b*, and *b* P K; either of them will ſolve the Queſtion;

In the Rectangle Spheric Triangle P K *b*. *Plate* 8. *Figure* 1.

1. The Hypotenuſe P *b*, the Diſtance of the Pole from the Path of the Vertex, or Complement of the Latitude, equal to 38d. 28m.

2. The Leg K *b*, the Sun's Altitude, or the Complement of his Diſtance from the Vertex, equal to 33 Degrees.

3. The Angle P *b* K, (the Supplement of the Angle P *b* ♈, the Sun's Azimuth from the North) is the Sun's Azimuth from the South, in all North Latitudes; but from the North, in all South Latitudes.

4. The Angle *b* P K, the Complement of the Angle *b* P ♈, (the Horizon from Noon) is the Hour of the Day from Six.

1. For the Angle P *b* K, the Sun's Azimuth from the Meridian, the Proportion (by Chapter 5, Section 4, Problem 1, Caſe 1, in page 135) is,

As Radius .. T. c. Hypot. P *b* : : T. Leg K*b* .. S. c. Angle P *b* K.
As T. 45d. .. T. 51d. 32m. : : T. 33d. .. S. 54d. 49m. the Sun's Azimuth from the Eaſt. That is,

As Radius, is to the Tangent of the Latitude;

So is the Tangent of the Sun's Altitude (when in the Equinoctial) to the Sine Complement of his Azimuth from the South, that is 35d. 11m. South Eaſterly, or S E. by S. ¼ E. almoſt.

2. For the Angle P *b* K, the Hour from 6, the Proportion is

As S. Hypot. P*b* .. Radius : : S. Leg K*b* .. S. Angle *b*PK.
As S. 38d. 28m. .. S. 90d. : : S. 33d. com. .. S. 61d. 06m.
equal to 4h. 4m. That is;

As the Sine Complement of the Latitude, is to the Radius; So is the Sine of the Sun's Altitude (when in the Equinoctial) to the Sine of the Hour from Six, 61d. 6m. equal to 4h. 4m. which add to 6 makes 4m. after 10m. in the Morning; but had it been in the Afternoon, it muſt have been ſubtracted from 6.

In the ſame Triangle, five Problems more may be reſolved, which I leave for the Learner to invent.

Problem 6. The Latitude of a Place, the Sun's Place in the Ecliptic, and his obſerved Diſtance from the Vertex given; to find his Azimuth, and Hour of the Day.

The { *Latitude* — 51d. 32m. N. / *Sun's Place* 00d. 00. in ♊ / ⊙*'s Altitude* 36d. 00. A.M. } *given. The* { *Sun's Azimuth* / *Hour of the Day* } *requir'd*

To delineate this, *Plate* 8. *Figure* 1.

1. Draw a Parallel Circle, 54d. diſtance from ⊙, (the Place of the Sun) and where it cuts the Path (of the Vertex) is the Place of the Vertex, when its Diſtance from the Sun is 54d. or when the Sun's Altitude is 36d. as here it doth at 7 and 5.

2. Through 7 and P; and through 7 and ⊙, draw Great-Circles, which will form the Oblique Spheric Triangle ⊙ P 7; the like may be done thro' 5 and P, and thro' 5 and ⊙; which will form two other Triangles equal to them.

In the Oblique Spheric Triangle ⊙ P 7. *Plate* 8. *Fig.* 1.

1. The Side P ⊙, the Diſtance of the Sun from the Pole, found by Problem 1. to be 69d. 49m. the Complement of the Reflection 20d. 11m. equal to the Sun's Declination.

2. The Side P 7, the Diſtance of the Pole from the Vertex, or the Complement of the Latitude equal to 38d. 28m.

3. The Side ⊙ 7, the Sun's Diſtance from the Vertex, or the Complement of his Altitude in the Forenoon 54d. 00m.

4. The Angle P 7 ⊙, the Sun's Azimuth from the North.

5. The Angle ⊙ P 7, the Hour of the Day from Noon.

The Angles P 7 ⊙ and ⊙ P 7 may be found by *Chapter* 5. *Section* 5, *Problem* 11, *Caſe* 11, of *Oblique Spheric Trigonometry*, in *Pages* 147 and 148, for there are three Sides given, to find an Angle; and when wrought you'll find the Angle P 7 ⊙ 103d. 12

12m. the Sun's Azimuth, from the North, or 76d. 48m. from the South Eaſterly, which makes E. by S. almoſt.

And the Angle ⊙ P 7 is 57d. 04m. or 3h. 48m. the Hour from Noon, which is 8h. 12m. in the Morning.

But had it been in the Afternoon, then the Hour of the Day is 3h. 48m. and the Azimuth 76d. 48m. South Weſterly; or W. by S. almoſt.

In this Triangle may Problem 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 of Section 3. of this Chapter be reſolved.

Problem 7. The Longitude and Latitude of a Star given; to find its Right Aſcenſion and Declination.

Example. *Let the oppoſite Star be* Capella, *and ſuppoſing its*
Longitude 18d. 02m. in ♊ } *what is it's* { *Right Aſcenſion?*
Latitude 22d. 52m. North } *what is it's* { *Declination?*

To delineate this Problem. *Plate* 8. *Figure* 1.

1. Lay off the Star's Longitude 78d. 02m. (from the Chords) on the Primitive Circle from ♈ to *y*, and draw the Circle of Longitude K *y*.

2. From the Half-Tangents lay 67d. 08m. (the Complement of the Star's Latitude, or its Diſtance from the neareſt Pole of the Ecliptic) on the Circle of Longitude from K to ✱.

3. Thro' P and ✱, draw a Great-Circle, which is a Meridian paſſing over the Star, and 'tis done.

In the Oblique Spheric Triangle K P ✱, *Plate* 8. *Figure* 1. Obſerve:

1. The Side PK, the Diſtance of the two Poles, or Line of Direction of the Earth's Axis equal to 23d. 29m.

2. The Side K ✱, the Star's Diſtance from the Pole of the Ecliptic, or the Complement of its Latitude, equal to 67 deg. 08 min.

3. The Angle P K ✱, the Star's Longitude from the Solſtitial Colure, in this Problem 11d. 58m. from ♋.

4. The Angle P K ✱, the Star's Right Aſcenſion from the oppoſite Point of the ſame Colure.

5. The Side P ✱, the Star's Diſtance from the Pole of the Globe, or Complement of his Declination.

So that here are two Sides, and an Angle between them given, to find an Angle, and the third Side; which is performed by Chapter 5, Section 5, Problem 9, Caſes 7 and 8, of *Oblique Spheric Trigonometry*, in Pages 144 and 145, and being the ſame as Problem 11. of Section 3. of this Chapter, in Page 234. I leave it to the Learner's Working.

Problem 8. The Latitude of a Place, the Sun's place in the Ecliptic, and the Time of the Day given; to find what point of the Ecliptic culminates, the higheſt Point of the Ecliptic, (called the *Nonageſima Degree*, or 90th Degree of the Ecliptic) the Diſtance of each of theſe from the Vertex, and the Parallactic Angle, or Angle which the Vertical Circle makes with the Ecliptic.

It's uſual to find theſe things in the Calculation of Eclipſes, and the Moon's paſſing over Fixed Stars; which in the *Ptolomaic Projection*, are with much Difficulty ſhewn, but in this moſt readily and eaſily repreſented.

Example.

Latitude 51d. 32m. N.
Sun's place 00d. 00m. in ♊
Hour —— 9h. 00m. AM.
} given; the {
Point Culminating,
Nonageſima Degree,
Vert. Diſt. of each
} required? To delineate this, *Plate* 8. *Figure* 1.

1. The Sun's place, proper Meridian, and Path of the Vertex, being drawn as before, draw an Hour Circle, or Meridian thro' P, making an Angle with the proper Meridian of 45d. (the Diſtance of the given Hour from the proper Meridian) as P 9, to cut the Path of the Vertex in 9, and the Earth's Ecliptic in C, and in F.

2. Thro' ☉ 9, and D, draw a Vertical Circle; and through K, and 9, draw a Circle of Longitude, to cut the primitive Circle in N, and 'tis done: For,

1. C is the Point of the Ecliptic Culminating, or in the Meridian of the Place, at the given Time.

2. N is the *Nonageſima Degree*, or the higheſt point of the Ecliptic at the ſame Time.

3. C 9 and N 9. are their reſpective Diſtances from *London*'s Vertex at that time.

4. The Angle N ☉ 9, is the parallactic Angle, or Angle which the Verticle Circle makes with the Ecliptic at the ſame time.

In the Rectangle Spheric Triangle P ♋ C.

1. The Angle C P ♋, is the Complement of the Right Aſcenſion of the Mid-heaven, or Point of the Ecliptic in the Meridian of the Place at the propoſed Time, being the Time from Noon, (when Afternoon added to the Sun's Right Aſcenſion, found by Problem 1. But when the propoſed Time is in the Forenoon it muſt be ſubtracted (in this Caſe is 77d. 11m. the Complement of 12d. 49m. found by ſubtracting (the Time) 45d. from 57d. 49m. the Sun's Right Aſcenſion.

2. The Leg P ♋, is the Complement of the Diſtance of the Poles of the Globe, and Ecliptic, equal to 66d. 31m.

3. The Leg C ♋, the Complement of ♈ C, is the Longitude of the Mid-heaven from ♋, or the point of the Ecliptic Culminating in the Meridian, at the propoſed Time.

4. The Hypotenuſe C P, is the Diſtance of the Mid-heaven from the next and neareſt Pole of the Globe, at the ſame Time.

1. For the Leg C ♋, the Point Culminating, the Proportion by Chapter 5, Section 4, Problem 3, Caſe 7, in pages 137 and 138, is;

As Radius ·· S. Leg P ♋ : : T. Angle C P ♋ ·· S. Leg C ♋.

As S. 90d. ·· S. 66d. 31m. : : T. 77d. 11m. ·· T. 76d. 03m. whoſe Complement 13d. 57m. is ♈ C; therefore the Longitude of the Mid-heaven is 13d. 57m. in ♈.

2. For the Hypotenuſe C P the Proportion is;

Radius ·· S.c. Angle C P ♋ : : T.c. Leg. P ♋ .. T.c. Hypotenuſe CP.

S. 90d. .. S. 12d. 49m. : : S. 23d. 29m. .. S. 5d. 30m. whoſe Complement 84d. 30m. is P C, from which take away P 9 the Diſtance of the Pole from the Vertex 38d. 28m. the Remainder is 9 C, the Diſtance of the Mid-heaven from the Vertex 46d. 2m.

In the Oblique Spheric Triangle P 9 K.

1. The Side P K, the Diſtance of the two Poles 23d. 29m.

2. The Side P 9, the Complement of the Latitude of the Place 38d. 28m.

3. The Angle K P 9, the Difference of the Right Aſcenſion of the Mid heaven, and the firſt Point of *Capricorn*, equal to 102d. 49m. found by ſubtracting 270 Degrees, out of (12d. 49m. added to 360 Degrees, which is) 372d. 49m.

4. The Angle P K 9, the Longitude of the *Nonageſima*, from the firſt point of ♋.

5. The Side K 9, the Complement of the *Nonageſima*'s Diſtance from the Vertex.

Firſt, For the Angle P K 9, the Proportion by Chapter 5, Section 5, Problem 9, Caſe 7, in pages 144 and 145, is thus.

1. As the Sine of half the Sum of the Sides P 9, and P K, is to the Sine of half their Difference;

So is the Tangent Complement of half the Angle K P 9, to the Tangeut of half the Difference of the Angles P K 9, and P 9 K; Then,

2. As the Sine Complement of half the Sum of the Sides P 9, and P K, is to the Sine Complement of half their Difference;

So is the Tangent Complement of half the Angle K P 9, to the Tangent of half the Sum of the Angles P K 9 and P 9 K.

That is,

d. m. d. m. d. m. d. m.

1. As S. 30.59. ·· S. 07.29 : : T. 38.36 ·· T. 11.25. And
2. As S. 59.01. ·· S. 82.31 : : T. 38.36 ·· T. 42.43. Which

being added, is the Angle P K 9 ——— 54.08. equal to ♋ N.
which ſubtract from ——— ——— ——— 90.00.

Remainder is the Long. of the *Nonageſima* 35.52. from *Aries*.

Therefore the Place of the *Nonageſima* 5d. 52m. in *Taurus*.

Secondly, For the Side K 9, the Proportion is thus;

As S. Angle PK9 ·· S. Side P 9 : : S. Angle KP9 ·· S. Side K9.
As S. 54d. 08m. ·· S. 38d. 28m : : S. 102d. 49m. ·· S. 48d. 28m.
the Diſtance of the Vertex from the Pole of the Ecliptic; equal to which is the Altitude of the *Nonageſima*, whoſe Complement 41d. 32m. is N 9, its Diſtance from the Vertex.

Again, in the Rectangle Spheric Triangle ⊙ N 9.

1. The Leg ⊙ N, the Sun's Diſtance from the *Nonageſima*, in this Caſe 24d. 08m. found by ſubtracting ♈ N 35d. 52m. from ♈ ⊙ 60d. 00m.

2. The Leg N 9, the Diſtance of the *Nonageſima* from the Vertex found as above to be 41d. 32m.

3. The Hypotenuſe ⊙ 9, the Sun's Diſtance from the Vertex.

4. The Angle N ⊙ 9, made between the Virtical Circle and the Ecliptic, is the Parallactic Angle; to find which the Proportion (by Chapter 5, Section 4, Problem 5, Caſe 13, in pages 139 and 140) is,

As Radius ·· S. Leg ⊙ N : : T. c. Leg N 9 ·· T. c. Angle N ⊙ 9.
As S. 90d. ·· S. 24d. 08m. : : T. 48d. 28m. · T. 24d. 47m. whoſe, Complement is 65d. 13m. is the Parallactic Angle N ⊙ 9 at the Sun.

And for the Hypotenuſe ⊙ 9, the Sun's Diſtance from the Vertex, the Proportion is,

As Radius ·· S. c Leg ⊙ N : : S. c. Leg N 9 ·· S. c. Hypot. ⊙ 9.
As S. 90d. ·· S. 65d. 52m. : : S. 48d. 28m. ·· S. 43d. 5m. whoſe, Complement 46d. 55m. is the Sun's Diſtance from the Vertex, at the propoſed Time.

But to calculate the Parallactic Angle at the Moon, or at a Star, that has Latitude from the Ecliptic, it will require a little more Labour, as in the next Problem.

Problem 9. The Latitude of a Place, Sun's Place in the Ecliptic, Time of the Day or Night, and the Longitude, and Latitude of the Moon, or of a Star, being given; to find the Parallactic Angle at the Moon, or at the Star; and it's Diſtance from he Vertex.

Example.

atitude —— 51d. 32m. N.
un's Place 00d. 00m. in ♊
Iour ——— 9h. A. M.
Capella Lon. 18. 02 in ♊
s Latitude — 22. 52 N.
} given; the { Parallact. Ang. and Vertical Diſt. } *requir'd*

To delineate this. *Plate* 8. *Fig.* 1.

1. Lay off the Sun's Longitude, and draw the proper Meridian ath of the Vertex, and the Hour Circle according to the pro-oſed Time, the Vertical Circle, and Circle of Longitude, in all eſpects as before in *Problem* 8.

2. Lay off the Star's Longitude and Latitude, as before in *roblem* 7. then is N the Place of the *Nonageſima*, 9 the Vertex, d ✱ is the Star's Place.

3. Through ✱ and 9, draw a Great Circle, and 'tis done. For ✱ 9, is the Star's Diſtance from the Vertex; and the ngle K ✱ 9, the Complement of the Parallactic Angle requi-d: In order to find them by Calculation.

Firſt, Find the Place of the *Nonageſima* by *Problem* 8, which in *Taurus*, 5d. 52m. equal to ♈ N 35d. 52m.

Secondly, The *Nonageſima*'s Diſtance from the Vertex, which in N 9, is equal to 41d. 32m.

Then in the Oblique Spheric Triangle ✱ K 9.

1. The Side K ✱, the Star's Diſtance from the next Pole the Ecliptic, or the Complement of its Latitude, equal to 7d. 08m.

2. The Side K 9, the Diſtance of the Vertex from the ſaid ole, which is equal to the Altitude of the *Nonageſima*, 48d. 3m. found by *Problem* 8, in page 250.

3. The Angle ✱ K 9, the Difference of the Longitude of the ven Star, and the *Nonageſima*, equal to 42d. 10m. and is the ifference of ♈ N, 35d. 52m. and ♈ *y* 78d. 02m.

4. The Angle K ✱ 9, the Complement of the Parallactic ngle, at the given Star.

5. The Side ✱ 9, the Star's Diſtance from the Vertex.

Firſt, To find the Angle K ✱ 9, the Proportion by *Chap.* 5. *ction* 5, *Problem* 9, *Caſe* 7, in *Pages* 144 and 145, is,

1. As the Sine of half the Sum of the Sides K ✱; and K 9; is the Sine of half their Difference: So is the Tangent Complement

ment of half the Angle * K 9; to the Tangent of half the Difference of the Angle K 9 *; and K * 9. Then,

2. As the Sine Complement of half the Sum of the Sides K *, and K 9, is to the Sine Complement of half their Difference;

So is the Tangent Complement of half the Angle * K 9; to the Tangent of half the Sum of the Angles K 9 * and K * 9.

That is,

d. m. d. m. d. m. d. m.
1. As S. 57.48 .. S. 9.20 : : T. 68.55 .. T. 26.26. And,
2. As S. 52.12 .. S. 80.40 : : T. 68.55 .. T. 78.14. They being ſubſtracted, give the Angle K * 9 ——— 51.48 whoſe Complement 38d. 12m. is the parallectic Angle at *Capella*.

Secondly, To find * 9, the Vertical Diſtance, the Proportion is,
As S. Angle K * 9 .. S. Side K 9 : : S. Angle * K 9 .. S. Side * 9.
As S. 51d. 48m. .. S. 48d. 28m. : : S. 42d. 10m. .. S. 39d. 45m.

The Diſtance of the Star *Capella* from the Vertex at the Time propoſed.

I might proceed to other Problems, and ſhew how they are formed and repreſented in this Projection, but I leave that for the Learner's Exerciſe.

I paſs by what (at firſt) I intended, which was the Orthographic Projection of the Globe; whereby the Moon's Appulſes to the Sun or Stars, and all the Appearances of an Eclipſe, Occultation or Tranſit, are repreſented to the Eye; uſeful to find the Longitude of Places, on the Globe of the Earth, a Thing much talk'd of, greatly deſired, and by ſome pretended to be found, though not made known, and I believe will never be made practicable at Sea: However by this Hypotheſis, with accurate Tables of the Moon and Stars Places, and a Way of taking an Altitude, or an Angle at Sea unto two or three Minutes; it might be made uſeful to obſerve for Longitude, and therefore it's highly worthy of our Seamen's Study; but without ſuch Altitudes, it will not find the Longitude unto two or three Degrees: And for Encouragement hereunto, the Government hath by an Act of Parliament promiſed Twenty Thouſand Pounds; and for the Learner's Help herein, I am ready to communicate all the Aſſiſtance I can elſewhere; for here's now no Place for it, leſt the Book (ſwelling too big) ſhould be deform'd.

And note; Theſe two Figures in *Plate* the 8th, are the Repreſentation of the two Hemiſpheres before deſcribed in Chapter 6, Section 4, in pages 180 and 181. So that in thoſe larger, all theſe Problems may be more exactly formed, and their Re-

Requiſites more truly meaſured; and if the particular Circles belonging to any Problem, ſuch as the proper Meridian, other Meridians, Hour Circles, Path of the Vertex, Circles of Longitude, and Vertical Circles, to a particular Time, *&c.* were drawn with Black Lead, they may be wiped out at Pleaſure, and the Hemiſphere no ways damaged.

And when any Circle happens ſo large as not eaſily to be drawn, or ſtruck with Compaſſes, it may be done with a Bow of the Length of the Diameter of the Hemiſpheres; ſuch being well made with 3 Screws, by their turning, will riſe up to the ſeveral Circles, that may (in the Projection) be required to be drawn.

CHAPTER X. *Of the Variation of the Compaſs, what it is, how to find it, and how to rectify the Compaſs thereby.*

Definition 1. *Variation of the Compaſs*, is an Arc of the Horizon contained between the Meridian of the Place, and the Magnetic Meridian; it's either Eaſt, or Weſt, and never exceeds 90 Degrees.

2. *Eaſt Variation*, is when the North Point of the Magnetic Meridian lieth Eaſtward of the North Point of the Meridian of the Place; but if to the Weſtward, then it is called Weſt Variation.

3. *Magnetic Meridian*, is a Great Circle paſſing thro', or by the Magnetic Poles; to which Meridian, the Compaſs (if not otherwiſe hindred) hath reſpect.

4. *Magnetic Poles*, are two moving oppoſite Points, making their Revolutions about the Poles of the World (as Mr. *Bond* ſaid in his *Longitude found*, page 7.) in 600 Years, in a Circle about 8d. 30m. diſtant therefrom; and their Motion (according to his Account) is the Cauſe of the Variation of the Compaſs.

5. *The Variation of the Compaſs* is found by an Amplitude, or an Azimuth.

6. To find the *Variation of the Compaſs* by an Amplitude, you muſt have the Latitude of the Place, the Declination, and Magnetic Amplitude of the Sun, given.

7. *Magnetic Amplitude*, is an Arc of the Horizon, contained between the Sun (at his Riſing or Setting) and the Eaſt or Weſt Points of the Compaſs ſteered by; Or, it's the apparent Riſing, or Setting of the Sun from the Eaſt, or Weſt Points of the ſaid Compaſs, and is found by obſerving the Sun, either at his Riſing, or Setting, with an Amplitude Compaſs.

8. *Amplitude*, is an Arc of the Horizon, contained between the Sun and the Eaſt, or Weſt Points of the Horizon; and is found by Chapter 9, Section 2, Problem 4, in pages 216 and 217, which I call the true Amplitude.

9. If the foregoing Amplitudes agree, that is the Magnetic and True Amplitudes (which is ſeldom) there is no Variation; but if they differ, their Differ. rightly counted is the Variation.

Note here; If you always count both Amplitudes from the North; then this is a General Rule.

At Sun Riſing $\left\{\begin{array}{l}\text{True———}\\ \text{Magnetic—}\end{array}\right\}$ Amplitude greateſt, the

Variation is $\left\{\begin{array}{l}\text{Eaſt}\\ \text{Weſt}\end{array}\right\}$ But at Sun's Setting its $\left\{\begin{array}{l}\text{Weſt.}\\ \text{Eaſt.}\end{array}\right.$

Example 1. At Sun Riſing, ſuppoſe the True Amplitude be Eaſt 33 Degrees Northerly, and the Magnetic Amplitude be Eaſt 17 Degrees Northerly; then counting both theſe from the North, the True Amplitude will be North 57 Degrees Eaſterly, and the Magnetic North 73 Degrees Eaſterly; the Magnetic is the greateſt, and the Difference is 16 Degrees, which is the Variation Weſterly: If this had been at Sun-ſetting, the Variation would then be Eaſterly.

Example 2. At Sun ſetting let the true Amplitude be Weſt 16 Degrees Northerly, and the Magnetic Amplitude Weſt 9 Degrees Southerly, both counted from the North, the True Amplitude is North 74 Degrees Weſterly, and the Magnetic is 99 Degrees from the North, and is the greateſt; their Difference is 25 Degrees, which is the Variation Eaſterly.

Or thus, in theſe two Rules.

1. The Amplitudes, both North, or both South; their Difference is the Variation: But one North, the other South, their Sum is the Variation.

2. Both the Amplitudes (before your Face) from you, if the True Amplitude be to the Right-hand of the Megnetic, the Variation is Eaſt; but when it's to the Left-hand, then the Variation is Weſt.

Theſe Rules will be exemplified in the Problem and Examples following.

Problem 1. The Latitude of the Place, the Sun's Declination and Magnetic Amplitude given; to find the Variation of the Compaſs.

Plat. 8. Fig. 1.

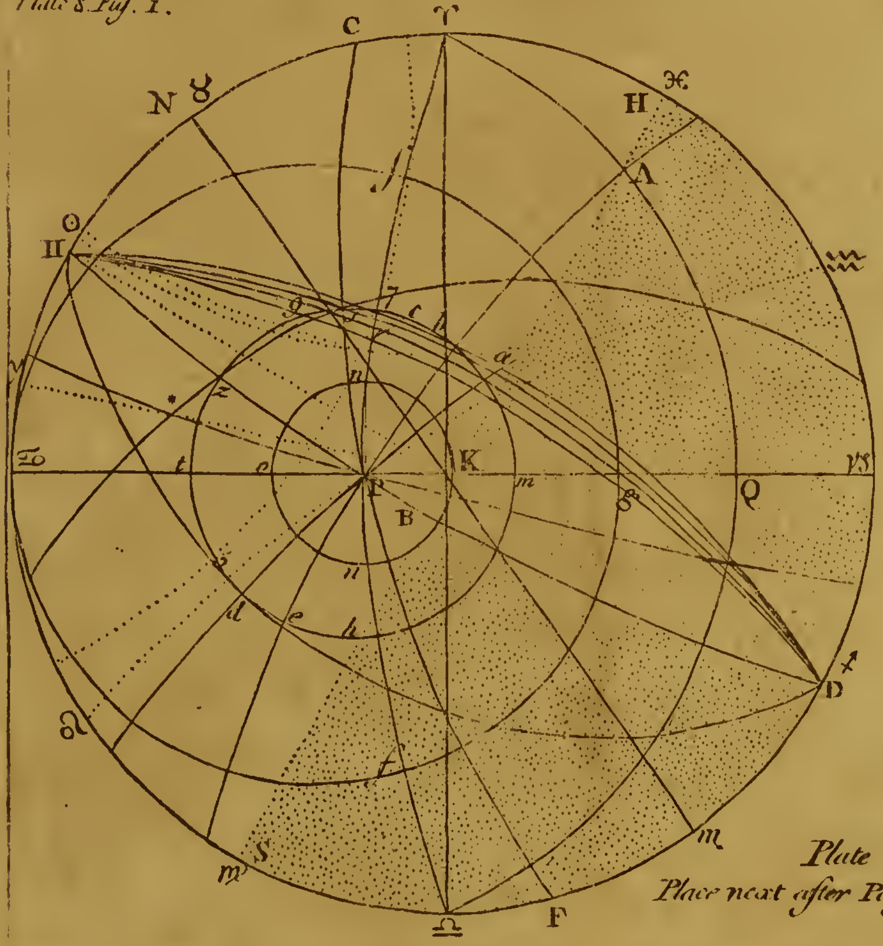


Fig. 2.

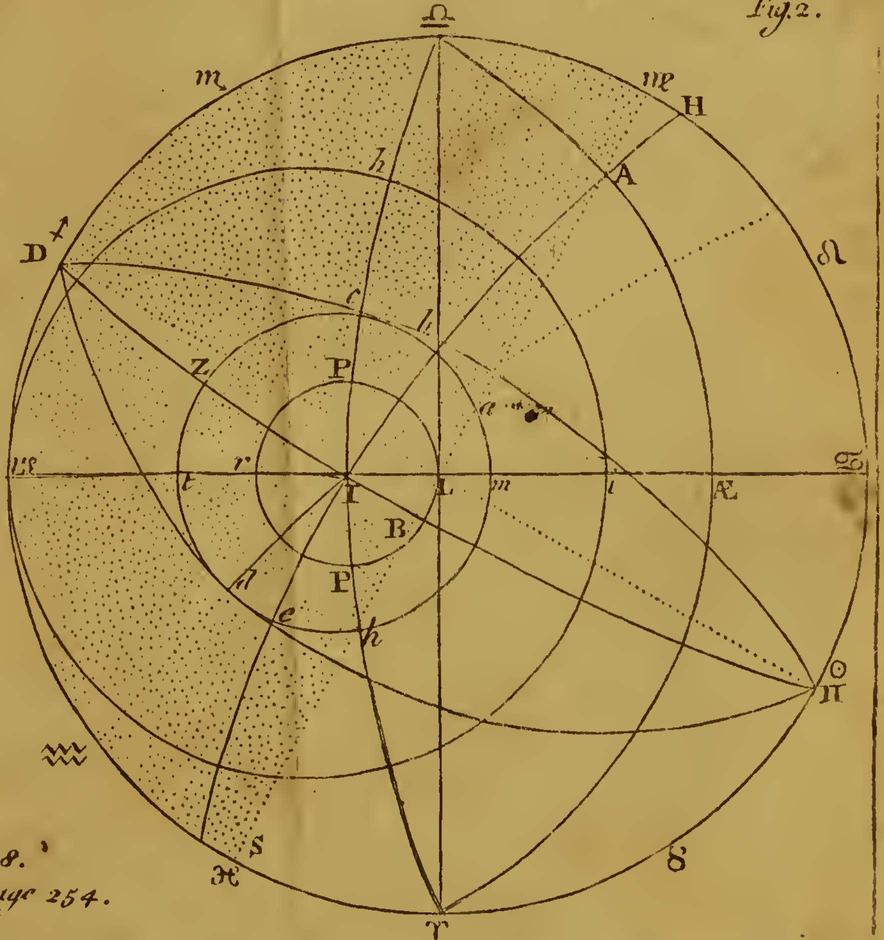


Plate 8.

Place next after Page 254.

Example.

he { Latitude ——————— 51d. 32m. } *North given;*
Sun's Declination ——— 20d. 10m. } *The Variat. is*
⊙ Magnetic Amplitude — 17 10 A. M. } *Required?*

To delineate this Problem Orthographically. Plate 9. *Figure* 1.

1. Deſcribe a Circle and quarter it; on whoſe Diameter place V. N. E. and S. (but always) N. at the Right-hand, and A at e Center of the Circle.

2. Lay the Lat. if $\left\{\begin{array}{c}\text{North}\\ \text{South}\end{array}\right\}$ from $\left\{\begin{array}{c}\text{N}\\ \text{S}\end{array}\right\}$ upwards to $\left\{\begin{array}{c}\text{P}\\ \text{I}\end{array}\right\}$ nd the ſame way from W to Æ, and draw the Axis PAI, and e Equinoctial ÆAQ.

3. By laying the Chord of the Sun's Declination on the Priitive Circle from the Equinoctial, draw the Parallel of Declinaon parallel to it; as the ſtreight Line *d*C*e*, to cut the Horizon AN, in C, the Place of the Sun's riſing, or ſetting.

4. Meaſure AC on the Line of Sines, it is the Sun's true Amlitude North, if the Declination be North; but South when the eclination is South.

5. Draw the Line CF, parallel to WAE (downward when it's M, but upward if it be PM) to cut the Primitive Circle in F.

6. Lay the Magnetic Amplit. if $\left\{\begin{array}{c}\text{A. M}\\ \text{P. M}\end{array}\right\}$ from $\left\{\begin{array}{c}\text{E}\\ \text{W}\end{array}\right\}$ to , on the Primitive Circle, towards N if it be North; But toards S when it is South.

7. The Diſtance from G to N, laid (the ſame way) from F to alſe North (which now is the North Point of the Compaſs, and is done.

For the Diſtance from N to Falſe North, meaſured on the cale of Chords, is the Variation of the Compaſs.

To find the Sun's true Amplitude, the Proportion by Chap. 9, ection 2, Problem 4, in page 217.

s S.c. Latitude ·· Radius : : S. ⊙ Declinat. ·· S. ⊙ Amplitude.
38. 28m. ·· S. 90d. : : S. 20d. 10m.N. ·· S. 33d. 39m. N.

		d. m.			d. m.	
n's true Ampl.	EF	33.39	EN.	or NF	56.21	North Eaſterly.
n's Magnetic.	EG	17.10	EN.	or NG	72.50	North Eaſterly.

ubtract gives the Variation ——————— 16.29 Weſt.

Example 2. d. m.

he { *Latitude* ——— 40.50 } *North* } *given; Variat. Req.*
Sun's Declination — 10.19 }
⊙'s *Magnet. Amp.* 15.10 *South* A.M. }

Am-

Anſwer. The Sun's true Amplitude is 13d. 42m. Eaſt Northerly found by the foreſaid Proportion, by which the Variation is found as follows;

d. m. d. m.
⊙ True Amplitude EF 13 42 EN. or NF 76 18 N. Eaſterly
⊙ Magnetic Amp. EG 15 10 E S. or NG 105 10 N. Eaſterly
Subſtract, gives the Variation ——— 28 52 Weſt.

The following Examples are for the Learner's Exerciſe, and ar wrought by the foreſaid Directions and Rules.

Example 3. d. m.
The Latitude ——— 13 10 North
Sun's Declination 15 40 South } given; Variation req
⊙ Magnet. Ampl. 9 12 S.P.M.

According to the foreſaid Rules, it's as follows:

d. m. d. m.
⊙ True Amplit. WF 16 06 WS. or NF 106 06 N. Weſterly
⊙ Magnet. —— WG 9 12 WS. or NG 99 12 N. Weſterly
Subſtract gives the Variation ——— 6 54 Weſt.

Example 4. d. m.
The Latitude ——— 50 40 ———
Sun's Declination 19 50 ——— } South given; Variat. req
Sun's Magne. Amp. 5 15 N.P.M.

Anſwer. The Variation is 27d. 17m. Weſt.

Example 5. d. m.
The Latitude ——— 21 30 ——— } North
Sun's Declination 19 56 ——— } given; Variation required?
Sun's Magnet. Amp. 10 17 South P. M.

Anſwer. The Variation is 29d. 39m. Eaſt.

Example 6. d. m.
The Latitude ——— 25 30 South
Sun's Declination 18 12 North } given; Variat. req
Sun's Magnet. Amp. 9 50 S. A. M.

Anſwer. The Variation is 30d. 5m. Weſt.

Secondly, To find the Variation of the Compaſs by an Azimuth obſerve theſe following Definitions.

1. *Magnetic Azimuth,* is an Arc of the Horizon contained between the Sun's Azimuth Circle, and the Magnetic Meridian; O it's the apparent Diſtance of the Sun from the North, or Sout Point of the Compaſs; and is found by obſerving the Sun by th Azimuth Compaſs, either in the Forenoon or Afternoon, whe he is about 5, 10 or 15 Degrees high.

2. *Azimuth,* is an Arc of the Horizon contained betwee th

hat Azimuth Circle, which paſſeth over the Sun, and the Merilian of the Place, this is called the true Azimuth, and is found by *Chap.* 9, *Sect.* 5, *Prob.* 1, of *Aſtronomy*, in pages 229 and 230.

3. If the ſaid Azimuths agree; that is, if the True Azimuth, nd Magnetic Azimuth agree, there is no Variation; but if they iffer, their Difference is the Variation; for which, rightly to ccount, obſerve this General Rule.

Reckon always both Azimuths (like as I ſaid for Amplitude in age 254.) from the North.

In the Forenoon the $\left\{\begin{array}{l}\text{True}\\ \text{Magnetic}\end{array}\right\}$ Azimuth greateſt, the Variation is $\left\{\begin{array}{l}\text{Eaſt}\\ \text{Weſt}\end{array}\right\}$ But in the Afternoon it's $\left\{\begin{array}{l}\text{Weſt.}\\ \text{Eaſt.}\end{array}\right.$

Example 1. In the Forenoon, Suppoſe the Sun's true Azimuth rom the North to be 80 Degrees, and the Magnetic Azimuth at he ſame Time to be 101 Degrees, the Magnetic is the greateſt, nd their Difference 21 Degrees is the Variation of the Compaſs Veſterly; but Eaſterly, had it been in the Afternoon.

Example 2. In the Afternoon let the Sun's true Azimuth be 115 Degrees from the North, and the Magnetic Azimuth 101 Derees, their Difference 14 Degrees is the Variation Weſterly; ut Eaſterly, had it been in the Forenoon.

Or thus, by the following Rules.

1. Always count both Azimuths from the North, in North atitude; but from the South in South Latitude.

2. The leſs Azimuth ſubtract from the greater, gives the ariation.

3. Placing both the Azimuths (before your Face) from you, if ne true Azimuth be to the Right-hand of the Magnetic, the Va-ation is Eaſt; but if to the Left-hand the Variation is Weſt.

Theſe Rules will appear plain in working the *Examples* of the ext *Problem.*

roblem 2. *The Latitude of the Place, the Sun's Altitude, Sun's Declination, and his Magnetic Azimuth given, to find the Variation of the Compaſs?*

Example 1.

			d.	m.		
The		Latitude ——	51	32	North	given: Variation required?
	Sun's	Altitude ——	11	30	A. M.	
		Declination -	15	10	North	
		Magn. Azim.	101	10	North	

To delineate this *Problem Orthographically*, Plate 9. Fig 2.

1. Deſcribe a Circle, quarter it, lay off the Latitude, draw the Equinoctial, Axis, and Parallel of Declination, in all Reſpects as before directed, (in *Prob.* 1, page 255.)

2. By laying the Chord of the Sun's Altitude on the Primitive Circle from the Horizon SAN, draw the Parallel of Altitude parallel to it, as is the Line *a* C *b*, to cut the Parallel of the Sun's Declination *d* C *e* in C; the Place of the Sun at that Time.

3. Draw C *b* parallel to WAE, downward when it's A. M. but upwards if it be P. M. till it meet in an Arc made (with half the Parallel of Altitude) from the Center (of the Primitive Circle) A, and cutteth the ſaid Arc in *b*.

4. By A and *b* draw a Line, to cut the Primitive Circle in F; then NF, or SF, meaſured on the Scale of Chords ſheweth the Sun's true Azimuth.

5. Lay the Magnetic Azimuth (if $\left\{\begin{array}{c}\text{North}\\ \text{South}\end{array}\right\}$ Latitude) from $\left\{\begin{array}{c}\text{N.}\\ \text{S.}\end{array}\right\}$ towards $\left\{\begin{array}{c}\text{E.}\\ \text{W.}\end{array}\right\}$ (when it is $\left\{\begin{array}{c}\text{A. M.}\\ \text{P. M.}\end{array}\right\}$) to G on the primitive Cir. But if $\left\{\begin{array}{c}\text{P. M.}\\ \text{A. M.}\end{array}\right\}$ towards $\left\{\begin{array}{c}\text{W.}\\ \text{E.}\end{array}\right\}$ to the ſaid G.

6. The Diſtance from G to N, laid (the ſame Way) from F to Falſe North, which is now the North Point of the Compaſs, and it's done.

For the Diſtance from N. to Falſe North, meaſured on the Scale of Chords, is the Variation of the Compaſs required.

Then to find the Sun's true Azimuth, the Proportion by *Chapter* 9, *Section* 3, *Problem* 1, in pages 229 and 230, is thus;

	d. m.
	90.00
Latitude — —	51.32
Comp. Lat. —	38.28
Comp. ⊙ *Alt.*	78.30
⊙'*s diſt. fr. pole*	74.50
Sum is — —	191.48
The half Sum is	95.54
The Remain. is	21.04

	d. m.		d. m.
	90.00		90.00
N. ⊙ *Alt.*	11.30 A. M.	⊙ *Decl.*	15.10 N.
Com. ⊙ *Alt.*	78.30	⊙ *diſt. fr. pole*	74.50

Radius S. c. .. *Lat.* : : S. c. ⊙ *Alt.* .. a 4th *Sine*

	d. m.	d. m.	d. m.
S. 90d. ..	S. 38.28 : :	S. 78.30 ..	S. 37.33

Then again,

4th *Sine* .. S. *half Sum* : : S. *Rem.* .. a 5th *Sine*

S. 37.33 .. S. 95.54 : : S. 21.04 .. S. 35.55

And againſt Sine 35d. 55m. on the Verſed Sines, is the

Sun's true Azimuth —— ——	80d. 02m. North Eaſterly.
Sun's Magnetic Azimuth ——	101d. 10m. North Eaſterly.
Subſtract giveth the Variation ——	21. 08m. Weſt.

And for the Learner's Practice, take theſe following Examples, whoſe Anſwers are found by the Rules foregoing.

Example 2.

			d. m.	
The	Latitude	—— ——	13 10 North	given: Variation required?
	Sun's	Altitude ——	17 50 A. M.	
		Declination —	16 59 South	
		Magnet. Azim.	90 10 North	

	d. m.	
		d. m. d. m.
	90.00	90.00 90.00
Latitude ——	13.10	N. ⊙'s Altit. 17.50 A. M. ⊙'s Decl. 16.59.S.
Com. Latitude	76.50	*Comp. Alt.* 72.10 ⊙'s *diſt. fr. Pole* 106.59
Com. ⊙'s *Altit.*	72.10	*Radius* .. S.c.*Lat.* : : S. c. ⊙'s *Alt.* .. a 4th *Sine*
⊙'s *diſt. fro. p.*	106.59	d. m. d. m. d. m.
Sum is ——	255.59	S. 90d. .. S. 76.50 : : S. 72.10 .. S. 67.48
The half Sum	127.59	Then again,
The Remain. is	21.00	4th *Sine* .. S. ½ *Sum* : : S. *Rem.* .. a 5th *Sine*
		S. 67.48 .. S. 127.59 : : S. 21.00 .. S. 17.45

And againſt Sines 17d. 45m. on the Verſed Sines, is the

⊙'s True Azimuth —— —— 113d. 00m. North Eaſterly

⊙'s Magnetic Azimuth —— —— 90d. 10m. North Eaſterly

Subſtract giveth the Variation —— 22d. 50m. Eaſt

Example 3.

			d. m.	
The	Latitude	—— ——	28.40 North	given: Variation required?
	Sun's	Altitude —— —	20.19 P. M.	
		Declination ——	19.12 South	
		Magnet. Azim. --	129.50 North	

Anſwer. By the foreſaid Directions, the

⊙'s True Azimuth —— —— 127d. 02m. N. Weſterly.

⊙'s Magnetic Azimuth —— —— 129d. 50m. N. Weſterly.

Subſtract giveth the Variation —— 2d. 48m. Eaſt.

Example 4.

			d. m.	
The	Latitude	—— ——	50 40 South	given: Variation required?
	Sun's	Altitude ——	25 10 P. M.	
		Declination ——	23 30 South	
		Magnet. Azim. -	100 20 South	

Anſwer. The Variation is —— 17d. 20m. Weſt.

Example 5.

			d. m.	
The	Latitude	—— ——	23 10 South	given: Variation required?
	Sun's	Altitude —— —	10 15 A.M.	
		Declination ——	23 30 North	
		Magn. Azim. ---	102 40 South	

Anſwer. The Variation is —— 18d. 32m. Weſt.

Example 6.

			d. m.		
The	Latitude		37.45	South	given: Variation required?
	Sun's	Altitude	18.20	P. M.	
		Declination	20.15	North	
		Magne. Azim.	115.40	South	

Anſ. The Variation is 20d. 12m. Eaſt.

But the Variation may be found more eaſily by an Inſtrument called the *Rectifier*, whoſe Deſcription is as follows:

The Rectifier *deſcribed. Plate* 10.

This Inſtrument conſiſteth of two Parts, which are two Circles laid one upon another, and ſo faſtened together in their Centers, that they repreſent two Compaſſes, one fixed, the other moveable; each of them is divided into the 32 Points of the Compaſs, and 360 Degrees, and numbred both Ways, from the North, and from the South; and ending at the Eaſt, and Weſt, in 90 Degrees.

The fixed Compaſs, repreſents the Horizon, in which the North, and all the Points of the Compaſſes are fixed, and immoveable.

The moveable One, repreſents the Mariner's Compaſs ſteered by, in which the North, and all other Points are liable to Variation.

In the Center of the moveable Compaſs, is faſtened a Silk Thread, long enough to reach the out-ſide of the fixed Compaſs: But when it's made of Wood, there is an Index inſtead thereof: The Uſe is as follows.

1. *To find the Variation by the Rectifier.*

Note; Thoſe Degrees numbred from the North, and the South towards the Eaſt, are termed the Right-hand, and the others towards the Weſt, are called the Left-hand.

Example 1. *At Sun-riſing, Suppoſe the true Amplitude* 57d. *from the North, and the Magnetic* 73d. *from the North, What is the Variation of the Compaſs, and which Way?*

Place 73d. (from the North) on the Right-hand in the moveable Compaſs, to 57d. (from the North) on the Right-hand in the Immoveable Compaſs; then the North Point of the Moveable Compaſs, will ſtand at 16d. on the Left-hand in the Immoveable Compaſs, which ſheweth the Variation of the Compaſs is 16 Degrees Weſt.

Example 2. *In the Afternoon, let the true Azimuth be* 80 *Degrees from the North, and the Magnetic* 101 deg. *What is the Variation of the Compaſs, and which Way?*

Place 110d. from the North; that is, 79d. from the South on the Left-hand in the moveable Compaſs, to 80 deg. from the North, or Left-hand in the immoveable Compaſs; then the North Point in the moveable Compaſs ſtands at 21 deg. on the Right-hand in the immoveable Compaſs, which ſhews the Variation of the Compaſs to be 21 Degrees Eaſt.

Always counting Amplitude at Sun-riſing, and Azimuth in the Forenoon, to the Right-hand, or towards the Eaſt; but at Sun-ſetting, and in the Afternoon, count them to the Left-hand, towards the Weſt.

2. *To rectify the Courſe by the* Rectifier.

This Propoſition hath two Caſes.

Caſe 1. The Variation of the Compaſs, and the Courſe ſteered, being given; to find the true Courſe.

Example 1. *Suppoſe the* Variation *be* 21 *Degrees Eaſt, and the Courſe ſteered by the* Compaſs *is* N. E. by N. *I demand the true Courſe, the* Variation *being allowed?*

1. Place the N. Point of the moveable Compaſs to 21d. from the North on the Right-hand in the immoveable Compaſs.

2. Lay the Thread or Index (which is faſtened in the Center) over the N. E. by N. Point in the moveable Compaſs, keeping it ſtreight out; then in the immoveable Compaſs the Thread or Index will lie on 55 Degrees, or near N. E. by E. which is the true Courſe required.

Example 2. *The* Variation 14 deg. *Weſt, and the Courſe ſteer'd by the Compaſs,* E. S. E. *I demand the Ship's true Courſe?*

1. Place the North in the moveable Compaſs to 14 deg. Weſt, in the immoveable.

2. Stretch out the Thread, or Index, over E. S. E. in the moveable, and it will lie on 82 Degrees in the immoveable Compaſs, or E. by S. a quarter E. the true Courſe required.

Caſe 2. *The* Variation *of the Compaſs, and the true Courſe given; to find the Courſe by the Compaſs?*

Example. *The* Variation 21 deg. *Eaſt, and the true Courſe I ſhould ſteer is* N. E. by E. *What Courſe muſt I ſteer by the Compaſs, to allow the* Variation?

1. Place the North, in the moveable Compaſs to 21 Degrees Eaſt in the immoveable Compaſs.

2. Stretch out the Thread over N. E. by E. in the immoveable Compaſs, and then in the moveable Compaſs, it will lie on 35 Degrees, or near N. E. by N. the Courſe you muſt ſteer to allow for the Variation of the Compaſs.

Here I thought to deſcribe the Azimuth Compaſs, and how to obſerve by it; but conſidering it's an Inſtrument eaſily underſtood, that Diſcourſe may be ſpared.

CHAPTER XI. *Of an* Obſervation, *either of Sun, or Star, what it is, how or with what, and when 'tis taken, and finding the* Latitude *thereby.*

1. AN Obſervation, is the finding either the Sun's or Star's Meridian Altitude (at Sea) with a Quadrant, or with a Croſs-ſtaff.

2. Meridian Altitude, is the Height above the Horizon of the Sun, or Star, they being upon the Meridian of the Place of Obſervation; and that the Sun is, every Day at Noon, but the Stars at different Times, according to the Difference of their ſeveral Right Aſcenſions from the Sun's Right Aſcenſion.

3. A Quadrant is the Inſtrument whereby only the Sun's Altitude (at Sea) is found; but by *Hadley*'s Quadrant the Altitude of a Star may be determined.

4. A Croſs-ſtaff or Fore-ſtaff, is an Inſtrument whereby Mariners find either the Sun's, or Star's Altitude. The particular Deſcription of *Davis*'s Quadrant and the Croſs-ſtaff I here omit, having done it largely in the *Mariner's-Compaſs Rectified*, to which Book I refer the Learner, and will now ſhew how to find the Latitude after you have obſerved, which is called, working an Obſervation, and that in this one Propoſition.

Propoſition. *The Meridian Altitude of any Heavenly Object, and it's Declination given; to find the Latitude of the Place of Obſervation.*

In this Propoſition are two Caſes.

Caſe 1. *Where, or when the Object obſerved doth both Riſe and Set in 24 Hours. The Rules are theſe.*

Rule 1. The Meridian Altitude, and Declination of one Kind; that is, both North, or both South; the Difference of the Zenith Diſtance, and the Declination, is the Lat. required.

Note; When the Declination is greater than the Zenith Diſtance, the Latitude is of the ſame Name; but if leſs, then of a contrary Name to the Declination.

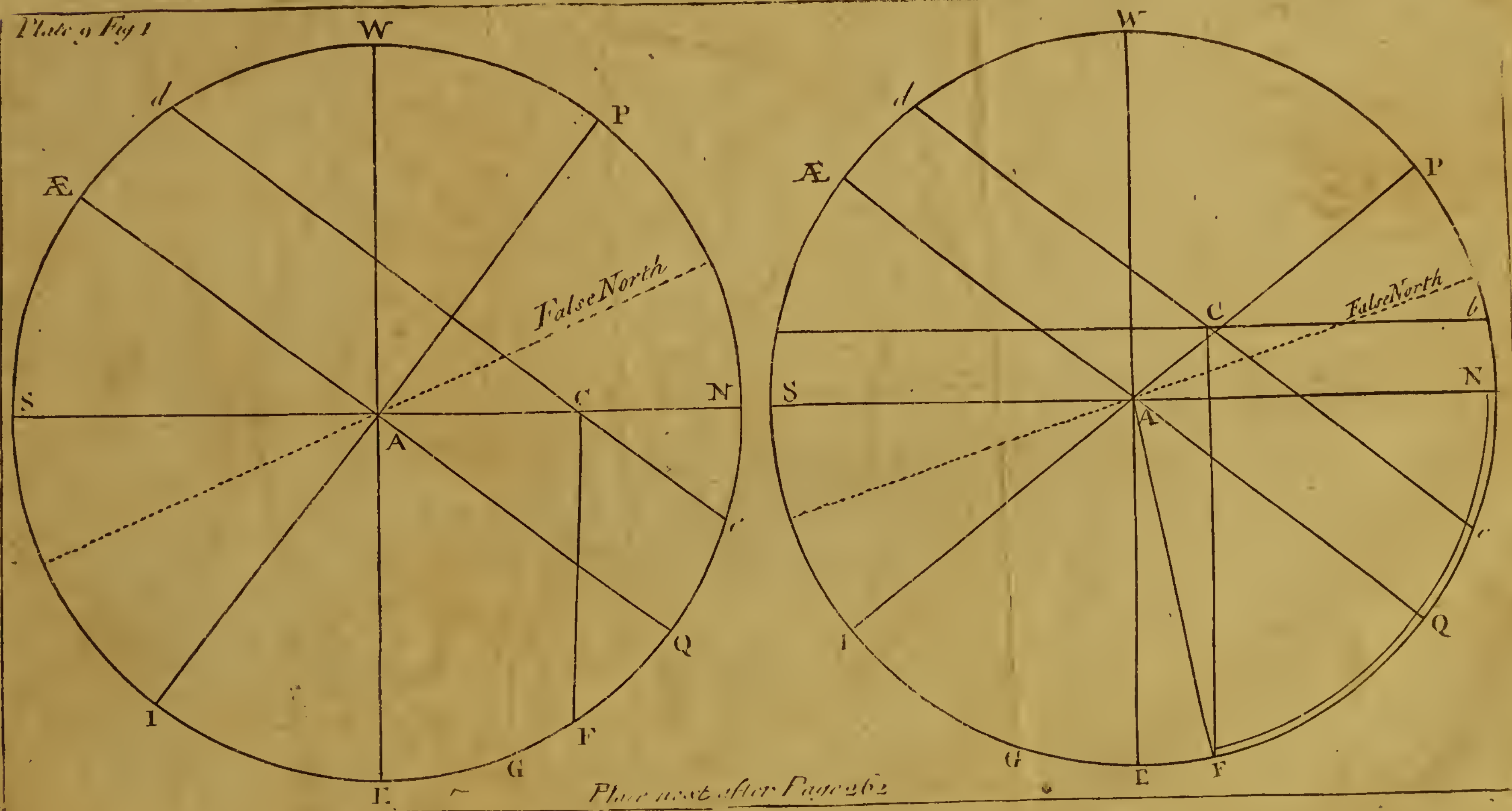
Rule 2. The Meridian Altitude, and Declination of contrary Names; that is, one North, and the other South, the Sum of the Zenith Diſtance and the Declination, is the Latitude required, of the ſame Name with the Declination.

Note 1. By Meridian Altitude South, I mean the Object obſerved is to the Southward of the Obſerver; and when North, then to the Northward of the Obſerver.

Note 2. By Zenith Diſtance underſtand the Complement of the Meridian Altitude of the Object obſerved.

Example

Plate 9 Fig 1



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Example 1. On the 20th of *May* 1760, the Sun's Meridian Altitude 61d. 08m. South; and his Declination 20d. 08m. North, What is the Latitude of the Place of Obſervation?

	d.	m.	
The Sun's Zenith Diſtance ——— ——— ———	28	52	South
Sun's Declination ———————————	20	08	North
The Sum (by *Rule* 2.) is the Lat. of the Place	49	00	North

Example 2. On the 1ſt of *July* 1758, the Sun's Zenith Diſtance being 11d. 50m. North, and his Declination 23d. 08m. North. What is the Latitude of the Place of Obſervation?

	d.	m.	
From the Sun's Declination ——— ——— ———	23	08	North
Subſtract the Sun's Zenith Diſtance ——— ———	11	50	North
The Rem. (by *Rule* 1.) is the Lat. of the Place	11	18	North

Example 3. On the 3d of *June* 1757, the Sun's Zenith Diſtance being 29d. 15m. South, and his Declination then 22d. 23m. North. What is the Lat. of the Place of Obſervation?

	d.	m.	
To the Sun's Zenith Diſtance ——— ——— ———	29	15	South
Add his Declination ——— ——— ———	22	23	North
The Sum (by *Rule* 2.) is the Lat. of the Place	51	38	North

Example 4. On the 22d of *Auguſt* 1758, the Star *Fomelhaut* being obſerved, and his Zenith Diſtance 20d. 17m. North, this Star's Declination (in page 178) is 30d. 56m. South. What is the Latitude of the Place of Obſervation?

	d.	m.	
To the Star's Zenith Diſtance ——— ———	20	17	North
Add the Star's Declination ——— ——— ———	30	56	South
The Sum is the Latitude required ——— ———	51	13	South

Example 5. The 30th of *September* 1759, the Foot of the *Croſiers* (by ſome called the *Cock's Foot)* a Star much uſed in Southern Voyages, being obſerved, his Meridian Altitude was 48d. 06m. South; this Star's Declination (in page 178) is 61d. 31m. South. What is the Latitude of the Place of Obſervation?

	d.	m.	
From the *Croſiers* Declination ——— ——— ———	61	31	South
Subſtract the Zenith's Diſtance ——— ——— ———	41	54	South
The Remainder is the Latitude required ———	19	37	South

Caſe 2. *Where, or when the Object obſerved doth neither Riſe, nor Set in 24 Hours; that is, doth not in the Diurnal Motion, move below or under the Horizon.*

Note 1. In ſome Parts of the Earthly World, both the Sun and Stars do not riſe or ſet, but are above the Horizon, and upon the Meridian of the ſame Place twice in the Space of 24 Hours; and this laſteth but for ſome Part of the Year with the Sun, but always with ſome Stars.

Note 2. When the Sun, or a Star, doth neither Riſe or Set, it cometh upon the Meridian below or under the Pole, that is, between the Pole and Horizon; and then it's at the leaſt Meridian Altitude.

Note 3. Some Stars in ſome Places come upon the Meridian both below, and alſo above the Pole, that is between the Zenith and the Pole, and then they are at their greateſt Meridian Altitudes.

Note 4. Where a Star cometh upon the Meridian both below, and alſo above the Pole, it's always to the Northward, both in its leaſt and greateſt Meridian Altitude, or elſe always to the Southward.

Note 5. Again, there are ſome Stars come upon the Meridian, to the Northward, and below the Pole; and to the Southward between the Zenith and the Equinoctial; and alſo to the Southward, and below the Pole; and to the Northward between the Zenith and the Equinoctial.

Note 6. When the Sun cometh to the Meridian below, or a Star, both above and below the Pole, the Latitude of that Place is of the ſame Name with the Sun or Star's Declination: That is, if the Sun or Star's Declination be North, the Latitude of the Place is North; but South, when the Declination is South.

Note 7. For thoſe Stars which never come (the Sun never doth come) to the Meridian above the Pole, at their greateſt Meridian Altitude, the former two Rules ſerve for to find the Latitude.

Then to find the Latitude by the Sun under the Pole, or Stars both under and above the Pole. The Rules are theſe.

Rule 3. The Object obſerved, being on the Meridian below the Pole, the Sum of the Meridian Altitude, and Complement of the Declination, is the Latitude required, of the ſame Name with the Declination.

Rule 4. The Object obſerved, being on the Meridian above the Pole, the Difference of the Meridian Altitude, and the Complement of the Declination is the Latitude required, of the ſame Name with the Declination.

Example 1. *Auguſt* 1, 1758, the Sun's Meridian Altitude below the Pole, or under the Pole, was found to be 5d. 30m. and his Declination 18d. 02m. North; What is the Latitude of the Place of Obſervation?

	d.	m.	
To the Complement of the Sun's Declination	71	58	North
Add his Meridian Altitude below the Pole —	5	30	
The Sum (by *Rule* 3.) is the Latitude ——	77	28	North

Example 2. On *December* the 18th, 1760, the *Bull's Eye Aldebaran* came upon the Meridian under the Pole, and his Meridian Altitude was obſerved to be 9d. 10m. this Star's Declination (in page 178.) is 15d. 58m. North; What is the Latitude of the Place of Obſervation?

	d.	m.	
To the Complement of *Bull's Eye* Declination	74	02	North
Add his Meridian Altitude under the Pole —	9	10	
The Sum (by *Rule* 3.) is the Latitude ——	83	12	North

Example 3. On *June* the 11th, 1759, the Foot of the *Croſiers* was obſerved under the Pole, its Meridian Altitude 21d. 25m. the Declination of this Star (in page 178.) is 61d. 31m. South: I demand the Latitude of the Place of Obſervation?

	d.	m.	
To the Complement of the Star's Declination	28	29	South
Add his Meridian Altitude —— —— ——	21	25	
The Sum by (*Rule* 3.) is the Latitude ——	49	54	South

Example 4. The 17th of *February*, 1761, the *Northern Pointer* of the *Great Bear* came to the Meridian above the Pole, and his Meridian Altitude was 56d. 10m. this Star's Declination is 63d. 05m. North: What is the Latitude of the Place of the Obſerver?

	d.	m.	
From the Star's Meridian Alt. above the Pole	56	10	
Subſtract the Complement of his Declination	26	55	North
Remainder (by *Rule* 4.) is the Latitude ——	29	15	North

Chapter XII. *A Sea-Reckoning, or Journal, what it is, and the Manner how it's kept, Directions to correct it, with an Example, and the Explanation thereof.*

THE keeping a good Reckoning or Journal, is not only the *Mariner's* Reputation, but (under God) the Preſervation

tion of a Ship, and all in it; the Ignorance thereof has been, (i not the only, I may ſay) the chief Cauſe of loſing divers ric Ships, and many dear and valuable Lives, and thence the impo veriſhing of ſeveral Families.

Then certainly, it ſhould be their great Concern, to be ex pert herein, who take on them the Navigating Ships to remot Places, when ſo great a Truſt as Mens Lives and Eſtates ar repoſed in them, that ſo, by a Knowledge of, and a conſtan careful Practice in keeping an exact Journal, they may not onl bear the Name of *Navigators*, but thereby prove themſelves de ſervedly worthy of the Title of *Compleat Artiſts*.

And for the compleat keeping a Journal, I prefer this Metho hereafter following; which tho' it be new, and uſed by few yet I doubt not but when better known, it will be more i Practice: Now that you may rightly underſtand what it is, an how to keep an Account of the Ship's Way by this new Form I ſhall thus explain it.

1. Know that a Journal, or Sea Reckoning, is a punctua writing down every Day (in a Book fit for that Purpoſe) th Courſe, Diſtance, Difference of Latitude and Departure th Ship hath made, what Latitude and Longitude ſhe is in; an alſo the Wind, Weather, with all Accidents and Occurrence that happen.

To perform which after the beſt manner, do theſe preparativ Things.

Firſt, Provide a Folio Book of 2, 3, or 4 Quire of large Paper and let it be ruled like the Log-Board, (in page 65) with Columns, taking up about half the Breadth of each page.

The 5 Columns may be marked or noted at the Head of eacl Column with Letters, thus;

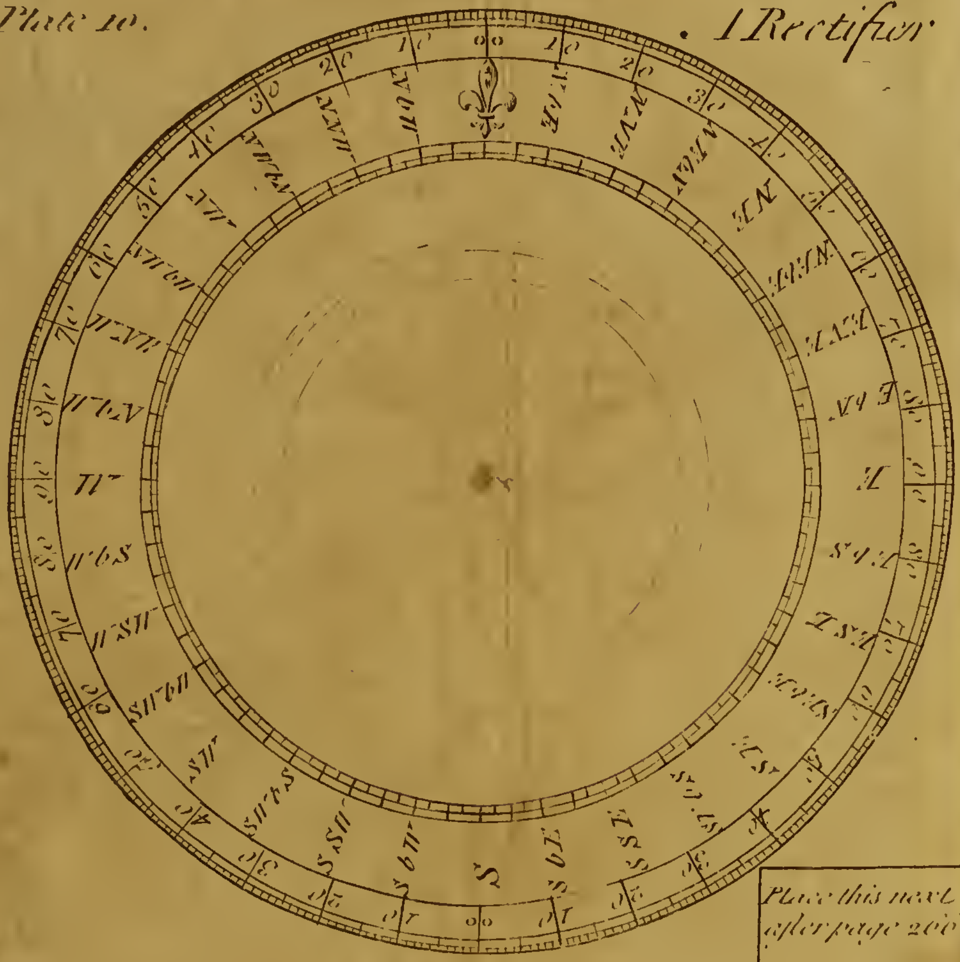
H	which ſtandeth for	Hours, under it are the Hours of the Day.	
K		Knots,	run out that Day.
F		Fathoms,	
C		Courſes, which have been ſteered that Day.	
W		Winds, which have blown that Day, *&c.*	

Secondly. Rule 12 Lines croſs the foreſaid 5 Columns, anc ſo far aſunder, that on Occaſion you may write two Lines o writing in the Spaces between thoſe Lines; then will the ſam Ruling ſerve for an *Eaſt-India* Voyage, or a Ship of War, i which the Log is heaved out every Hour, and alſo for othe Voyages, where it's uſed every two Hours.

Thirdly

Plate 10.

A Rectifier



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Thirdly, In the firſt Column (marked at the upper End with H) write down the Hours of the Day; that is for common Voyages, , 4, 6, 8, 10, 12, and 2, 4, 6, 8, 10, and 12: But for *Eaſt-Inia* Voyages or Ship of War, 1, 2, 3, &c. to 12 at Midnight; hen 1, 2, 3, &c. to 12 at Noon. And thus far is the Book fitted, nd prepared to copy off the Log-Board.

Fourthly, Under theſe 5 Columns let there be ruled 12 ſhort Columns, which may take up the whole Breadth of each Page of he Book. Theſe may be intitled as in the Journal following this Diſcourſe, (in pages 274 and 275) and need not any farther Explanation.

Now ſuch a Book, ſo ruled as here directed, each Page thereof will contain two Days Sailing, with all appertaining thereunto, as hall afterwards appear.

Firſt, Having a Journal-Book thus prepared, and now on your Departing, the firſt Thing is to enter the Title of the Journal, which may be done thus: In the Top or Head of the firſt Page of he Journal-Book, write the Title thereof in Words after the Form immediately before the Journal, in Page 273.

And now the Book is compleatly fitted for the Uſe intended, and that is keeping a Sea Reckoning, after this Manner.

2. Next under, or after the Title, (write in the blank Space between the fifth Column for the Wind, and the Side of the Book) the Year, Month, Day and Hour, you part with Sight of the Land, and alſo the Circumſtances and Actions attending the ſame, &c. as here you may ſee in the two firſt Sides of the Journal; which by Reaſon of the Smallneſs of this Book reacheth Pages 274 and 275, which are to be eſteemed but as one Page, or Side of the Journal.

3. Every Day or Noon, write in the 5 Columns the ſame you find written on the *Lag-Board*, which contains the Ship's Courſes ſteered, Diſtances run by the Log, what Winds have blown, what Sails handed, and when.

4. In the vacant Space of the Right-hand of theſe 5 Columns (which takes up more than half the Breadth of the Book) expreſs the Tranſactions of that Day, as Winds, Weather, Currents, ſetting of the Sea, handing of Sails, meeting or parting with Ships, Death of Men, Variation of the Compaſs, and all other Accidents and Occurrences whatſoever.

5. Then correct the ſeveral Courſes, by allowing for Leeway, Currents, and Variation, according to the Nature of

them; and bring them into one Courſe (by Chapter 3, Sectio
of *Plane Sailing*, in page 64.) by which, you will find the Sh
Diſtance, Difference of Latitude, and Departure from the M
dian, which being ſet down in the Columns bearing thoſe Tit
then (by Chapter 3, Section 3, General Rule 3, in page 58.) f
the Latitude the Ship is in, and ſet that in its proper Colum
(And by Chapter 4, Section 3, Problem 5, of *Mercator's Saili*
in pages 96 and 97, and by Section 2, of the ſame Chapter
page 91.) find the Longitude the Ship is in, and place that in
12th and laſt Column; and thus you finiſh the Days Work.

For *Leeward*, or *Leeway*, the Allowances are ſuch as in th
eight following Caſes.

Firſt, The Ship being upon a Wind, allow one Point
Leeway.

Secondly, The Wind blowing hard, ſo as to cauſe one Top-
to be taken in; allow two Points for Leeway.

Thirdly, When it blows ſo hard that both Top-ſails are taken
and the Sea runs high; allow then three Points for Leeway.

Fourthly, The Fore-ſails being furl'd, and the Ship tries un
a Main-ſail, and a Miſſen; allow four Points for Leeway, for
then makes her Way about four Points before the Beam (as
Sea Phraſe is.)

Fifthly, When the Ship tries under a Main-ſail only, ſhe th
makes her Way near three Points before the Beam, that is, n
five Points for Leeway.

Sixthly, If the Ship tries under a Miſſen only, her Way is ab
2 Points before the Beam; that is, allow 6 Points for Leeway.

Seventhly, When ſhe lies a Hull; that is, with all her S
furl'd, her Way is one Point before the Beam, and then ſe
Points is her Leeway.

Eighthly, If the Wind hath blown hard at WSW. and m
the Sea run high, the Ship ſtemmeth South, and the Wind ſh
ing to ESE. then whilſt the Sea continues to run high, it ſtri
the Ship on the Lee-Bow, and abates the Leeway.

Note; In all thoſe eight Caſes, Reſpect muſt be had to
Smoothneſs of the Water, or the Sea's running high, and th
the Allowances may be rectified with the greater Certainty,
ſetting the Ship's Wake by a Compaſs, placed on each Rail of
Ship's Quarter, which is uſually ſet there for that Purpoſe.

Theſe Directions, with a Conſideration of the Ship's Tri
Sail abroad, Streſs of Wind, and Growth of the Sea, being

in

Practice, will ſo improve the young Navigator's Judgment, he'll ſeldom fail of making good Allowance for the Ship's way.

. After this Manner are you to proceed every Day from on to Noon, which is the beginning and end of the Day ronomic, the Day by which the *Mariners* keep their Sea-koning.

. Remembering always to obſerve for the Latitude, when Op-tunity preſents, either by the Sun or Stars; That being the f Thing to be depended on, and by which the Reckoning is firmed or rectified, which is the next Thing to be treated of.

. When the Latitude by Account agrees with the Latitude Obſervation, then is the Reckoning confirmed, and you are it's kept well.

. But if they diſagree, then either the Ship hath out-run ır Reckoning, or your Reckoning hath out-run the Ship; there is ſome Error, either in the Courſe, Diſtance ſailed, both of them; Now to find where the Error lies, conſider, ether there be a Current, or not.

10. If there be a Current, try it, and find which way it ſets, how faſt; and by that correct both Courſe and Diſtance; if that makes the Reckoning Latitude to agree with the Ob-ved Latitude, you have then truly corrected the Reckoning. But if you, only by ſome probable Reaſon, conjecture there a Current, then give what Allowance you think meet to the fference of Latitude, and Departure, and ſee if that will reform ır Reckoning Latitude, that it agree with the obſerved Lati-e; if ſo, you have gueſſed well (for you muſt ever keep to the titude by Obſervation, that being the principal thing to be re-l upon) but if it will not agree with the Obſerved Latitude, to be ſuppoſed that there are Miſtakes in your Conjecture, or ne other Cauſe produces this Error in the Reckoning.

11. When there's no Current, nor any Variation, or if there either, or both, and they are allowed for according to Art and aſon, and yet your Account will not agree with the Obſerved titude; then there is an Error either in Steerage, or in the g, and to know in which it is, take this

General Rule.

ffer. of Latitude } the greater, the Error is in the { Log.
eparture ------ } { Courſe.

12. When there is an Error in the Courſe ſteered, you muſt ter the Allowances in the 10th and 11th Rules have been made)

made) then only correct the Difference of Latitude, and ſo ma the Latitude by Account to agree with the Latitude by Obſerv tion, and the Work is done.

13. But when the Error lieth in the Log, the Diſtance is faul and this is the Cauſe which moſt uſually makes the Difference b tween the Obſerved Latitude, and the Latitude by the Accou And herein are two Caſes.

Caſe 1. *In North Latitude, ſailing towards the North; and in So Latitude, ſailing towards the South.*

If the Obſerved Latitude be greater, then hath the Ship out-r the Reckoning; but if it be the leſs, the Reckoning hath out-r the Ship.

Caſe 2. *In North Latitude, ſailing towards the South; and in So Latitude, ſailing towards the North.*

If the Obſerved Latitude be greater, then hath the Reckoni out-run the Ship; but if it be leſs, the Ship hath out-run t Reckoning.

14. When the Ship hath out-run the Reckoning, then is t Reckoning too little, and the Difference between the Obſerv Latitude and Reckoning Latitude, muſt be added to the North South Column in the Reckoning; and ſo doing it's corrected.

15. But when the Reckoning hath out-run the Ship, then is t Reckoning too great, and the Difference between the Obſerved L titude and Reckoning Latitude, muſt be ſubſtracted from the No or South Columns in the Reckoning; and ſo doing, it's correcte

16. To correct the Departure (the Eaſt, or Weſt Column the Reckoning) when the Error is in the Diſtance, do thus: A up the N. S. E. and W. Columns from the Beginning, if it the firſt Error; otherwiſe from the laſt Error, or from the l Obſervation to the Day of the preſent Error; in order to find t Difference of Latitude and Departure; as was ſhewed in addi up the Columns in a Traverſe.

And then the Proportion to find the Error, or Correction in t Departure, is this;

As the Difference of Latitude, is to the Departure;
So is the Correction in Latitude, to the Correction in Departu

Note; Correction in Latitude, is the Difference between t Obſerved Latitude, and Reckoning Latitude.

The Correction in Departure muſt be added to, or ſubſtract from the Eaſt or Weſt Column in the Reckoning, according the 14th or 15th Rule aforeſaid; and ſo the Departure will corrected.

17. T

17. To correct the Longitude do thus; Find (by the Table of *Meridional Parts*) the Meridional Difference of Latitude, between he obſerved Latitude, and the Reckoning Latitude, and then the Proportion is this;

As the Correction in Lat. is to the Correction in Departure;

So is the Meridional Difference of Latitude, to the Correction in Longitude.

Then according to the new Way of Computation of Longitude n the *Mariner's Compaſs Rectified*, if the Longitude, and its Correction be both Eaſt, or both Weſt, add; but one Eaſt, and the other Weſt, ſubſtract, and the Longitude is corrected.

And having gone over the Rules, and Directions about keeping and correcting a Sea-Reckoning, or Journal; I will alſo give an *Example* of a Journal of an intended Voyage from the *Lizard* towards *Barbadoes*, that the foregoing Rules may be the better underſtood.

And altho' this following Journal be but an *Example* of ſeven Days (being ſo deſigned that this Book might not ſwell too big) yet it may be of ſufficient Intelligence to a diligent Reader, for he right Underſtanding this Method of Keeping and Correcting a Sea-Journal; eſpecially if the following Explanation be deliberately compared with the preceding Directions; and thereby as informing, as if the whole Series of the Voyage had been inſerted, which would have augmented both the Book and its Price, but not anſwerable to the Underſtanding thereof.

Having treated about Keeping and Correcting a Journal, which cannot well be done 'till the Errors in the Log-Line and Half-Minute-Glaſs, are rectified; I think it neceſſary here to ſay ſomething of both.

The Manner of keeping a Reckoning, or Sea-Journal (by our *Engliſh* Navigators) is by the Log-Line, and Half-Minute-Glaſs; Ought not Care then be taken that they be true, elſe a Reckoning kept by them muſt be falſe?

But it hath been an ancient Cuſtom, and ſtill is too much uſed, o meaſure 7 Fathom, or 42 Feet, between Knot and Knot on the Log-line, which is grounded on this Conjecture, That 5 Feet make a Pace, 1000 (ſuch) Paces a Mile, and 60 (ſuch Miles) make a Degree; that is, a Degree contains 300000 Feet, and a Mile (or Minute) 5000 Feet; and becauſe an Half-Minute of Time is the 120th Part of an Hour, and the 120th Part of (a Mile) 5000 Feet, is almoſt 42 Feet, this Meaſure is therefore too commonly put between each Knot on the Log-line.

But this Erroneous Computation hath been ſufficiently contradicted by Mr. *Oughtred*, Mr. *Norwood*, and others.

Mr. *Oughtred*, in his *Circles of Proportion*, in page 153, doth allow 66¼ Statute Miles to a Degree on the Earth, each Mile being 5280 Feet, ſo that in a Degree there are 349.800 Feet.

And Mr. *Richard Norwood* in his *Seaman's Practice*, page 43, doth prove a Degree on the Earth, to contain 367200 *Engliſh* Feet; but at length conſents to allow 360000 Feet to a Degree, and ſo 6000 Feet the 60th Part, to be one Minute, commonly called a Mile; ſo that 6000 Feet ſhould be the Number from whence the Knots on the Log-Line ought to be deduced.

Note; That the Meaſure of a Degree, nearly as above, has been fully proved by ſubſequent Experiments, and is now generally received by Mathematicians.

Therefore, if 6000 (the Feet in a Mile or Minute) be divided by 120 (the Half Minutes in one Hour) the Quotient is 50 Feet; for the Diſtance of each Knot, on the Log-line, and 25 Feet is half a Knot.

Now 5 being the one Tenth of 50, let each Fathom on the Log-line contain 5 Feet; and then 5 of theſe Fathoms make an Half Knot, and 10 of them one Knot.

And according to theſe Meaſures, let every Man that would keep a true Reckoning, and give a good Account of his Voyage, be perſuaded to mark his Log-Line, and not let Cuſtom prevail above Reaſon.

Hence it follows, That if a Ship runneth out one of theſe Knots in half a Minute, ſhe runneth one Mile or Minute, (the 60th Part of a Degree) in an Hour; if 2 Knots, then 2 Miles; if 3 Knots and 4 Fathoms, then Miles 3.4; that is, 3 Miles and 4 Tenths of a Mile in an Hour, and ſo for any other. And by ſuch a Log-line is the following Reckoning kept.

The like Regard muſt be had, that the Half Minute Glaſs be of a juſt Length, otherwiſe no true Account of the Ship's Way can be kept: Now for that, take an approv'd Experiment, mentioned by Mr. *Phillips*, in his *Advancement of Navigation*, the Second Part, page 9, as follows.

An eaſy and exact Way to meaſure an Half-Minute Glaſs.

Let a Plummet of any Form or Weight be faſtened to one End of a Thread, or Silk-ſtring, that is 38½ Inches long, and at the other End let be a Loop or Nooſe, to hang it on a ſmall Pin or Nail, faſtened in any Place, ſo that the Plummet may ſwing freely.

Then the Loop of the String being hung on the Pin, the String

ring 38½ Inches from the Center of Gravity to the Center of otion; that is 38½ Inches from the end of the Loop, to the iddle of the Plummet, and the Plummet cauſed to ſwing; ach of thoſe Swings ſhall be a true Second of Time, and 30 of hem the juſt Length of an Half-Minute-Glaſs.

Always counting the Swings both forward from, and back-ard to the Perpendicular, ſuppoſed to fall upon the Pin whereon e String doth hang; and then half a Second of Time is mea-ured every Time the Plummet paſſeth from the Perpendicular, to s utmoſt Swing either way; or a Second is reckoned for every ime it paſſes the Perpendicular.

But when the Ship hath any conſiderable Motion, make the tring 7 Inches ſhorter, and there make a Knot to hold it by, etween your Finger and Thumb; then by an eaſy Motion of e Wriſt, cauſe the Plummet to aſend to an Angle of about 60 egrees, from the foreſaid Perpendicular each way; and each wing ſhall be equal to thoſe before mentioned: So that by this xperiment you may meaſure a true Half Minute of Time ithout a Glaſs, and by it examine the Truth of thoſe you have.

A Journal of a VOYAGE,

(By GOD's Permiſſion)

IN THE

EORGE *of* LONDON. *A. B.* Commander.

FROM THE

izard in { Latitude 49d. 57m. North.
Longitude 5d. 14m. Weſt.

TO THE

ſland *Barbadoes* in { Latitude 12d. 58m. North.
Longitude 58d. 50m. Weſt.

Their Difference of Longitude 53d. 36m. Weſt.
The Courſe from the *Lizard*, S. 50d. 09m. Weſt. or SW. ½W.
Their Diſtance in that Rumb, 3463 Minutes.

Kept by *C. D* Chief Mate.

Began ♃ *January* 24th, 1760.

S

	H.	K	F. of 5 Feet.	C.	Wind and Weather.	
Afternoon.	2	5	2	W. by N.	N.N.E.	
	4	5	——	W.S.W.	N. *Scilly* N by W. 7 leag. off	
	6	5	6		N.N.E.	
	8	5	5			
	10	5	5	SW by W.	NW. by N.	Rain
	12	6	5	W.S.W.	North	Rain
After Midnight.	2	6	1		N. by E.	
	4	6	1			
	6	6	3		NE. by N.	Rain
	8	6	——	SW by W.		
	10	6	——	W.S.W.		
	12	6	——		E.N.E.	

Sum is 69 —— 8 Which doubled, is Min. 139.6

Month Days.	*Week Days.*	*Month and Year.*	*Courſe.*	*Diſtance ſailed in Minutes.*	*Diff. of Lat. in Min* N.	S.
24	♃	Jan. 1760.	South	18	——	18.0
25	♀		WSW.	137.4		51.4

♃ Th

♃ The 24th of *January*, 1760. At Noon, we ſaw the *Lizard* Point bear North about 18 Minutes or Miles Diſtance from us: We had variable Winds, freſh Gales, cloſe hazy rainy Weather, as *per Columns.*

In Company with the *Succeſs*, Capt. *E.F.* Commander, bound for the *Eaſt-Indies.*

♀ 25th, our Courſe and Diſtance made good this Day, I make W.S.W. 137.4 Minutes, with Latitude, Meridional Diſtance, and Longitude, as *per Columns* underneath.

	d. m.		d. m.	
⊙ *Zenith Diſtance* —		⊙ *Magnet. Amplitude*	48.49	ES.
⊙ *Declination* —		⊙ *True Amplitude* —	29.51	ES.
Lat. by Obſervation—		*Variation* —	18.58	W.

Depart. in Min.		*Latitude by Account in deg. and min.*	*Meridional Diſtance in deg. and min.*	*Longitnde by Account in deg. and min.*
E.	W.			
		49.39 North		05.14 W.
	127.5	48.48 North	02.07 W.	08.27 W.

	H.	K	F. of 5 Feet.	C.	Wind and Weather.
Afternoon.	2	6	——	W.S.W.	N.E. *Rain and Snow.*
	4	6	——	S. W.	
	6	5	8		*Rain and Snow.*
	8	7	1	SW by W.	N.E. by E. Rain
	10	7	——	W.S.W.	E.N.E. Rain
	12	7	1		NE. by N. Rain
After Midnight.	2	7	——		N.E. *Lightning.*
	4	6	8	SW by W.	NE. by E.
	6	7	2	W.S.W.	N.E.
	8	7	——		E.N.E. *Hail and Rain*
	10	6	2		Rain
	12	6	6		E. Rain

Sum is 79 —— 8 Which doubled, is Min. 159.6

Month Days.	*Week Days.*	*Month and Year.*	*Courſe.*	*Diſtance ſailed in Minutes.*	*Diff. of Lat. in Min.*	
					N.	S.
26	♄	Jan. 1760.	swbw½w	158	——	73.6

♀ The 25th of *January*, 1760, hard Gales of variable Winds, with ſome Snow, Hail and Rain.

Our Top-ſails reefed, and ſo have been ever ſince we ſaw the *Lizard.* A great ſwelling Sea following us, and ſetting towards the S.S.W.

Our Courſe and Diſtance I judge to be S.W. by W. half W. 158 Min. with Latitude, Meridional Diſtance and Longitude, as in the Columns underneath.

	d. m.		d. m.
☉ *Zenith Diſtance*	——	☉ *Magnet. Amplitude*	——
☉ *Declination*	——	○ *True Amplitude*	——
Latitude by Obſervation		*Variation*	——

Depart. in Min.		*Latitude by Account in deg. and min.*	*Meridional Diſtance in deg. and min.*	*Longitude by Account in deg. and min.*
E.	W.			
——	139.8	47.34 North	04.27 Weſt	11.58 Weſt

	H.	K.	F. of 5 Feet.	C.	Wind and Weather.	
Afternoon.	2	6	3	SW by W.	E.	*Hail and Rain*
	4	7	3	S.W.	*Handed Fore-Top-ſail*	Rain
	6	8	—		N.E.	Rain
	8	7	6			
	10	8	2			
	12	8	—			
After Midnight.	2	8	—			
	4	8	—			
	6	8	—			Rain
	8	8	1		*Handed Main Top-Sail*	Rain
	10	6	7			
	12	6	2			

Sum is 90——4 Which doubled is Min. 180.8

Month Days.	*Week Days.*	*Month and Year.*	*Courſe.*	*Diſtance ſailed in Minutes.*	*Diff. Lat. in Min.*	
					N.	S.
27	☉	Jan. 1760.	S.W.	180.5		125.9
		Corrected by Obſervation.			——	24.0
		Corrected.				149 9

♄ The 26th of *January*, 1760, bad Weather, very hard Gales, thick Air, with ſome Hail and Rain.

A great Sea after us, ſetting towards the S.S.W. for theſe three Days paſt.

By Obſervation the Ship hath out-run the Reckoning 24 Minutes South, which is attributed to the S.S.W. Sea.

Our Courſe and Diſtance corrected, is S.W. by S. 3 quarters W. 205 Minutes, with Meridional Diſtance, and Longitude, as underneath.

	d. m.		d. m.
⊙ *Zenith Diſtance*	63.36 S.	⊙ *Mag. Ampl.*	10.20 WS.
⊙ *Declination* —	18.32 S.	⊙ *True Ampl.*	28.16 WS.
Lat. by Obſervation	45.04 N.	*Variation* ——	17.56 W.

Depart. in Min.		*Latitude by Account in deg. and min.*	*Meridional Diſtance in deg. and min.*	*Longitude by Account in deg. and min.*
E.	W.			
	129.4	45.28 North	06.36 W.	15.07 W.
	09.9	00.24 South	00.10 W.	00.14 W.
	139.3	45.04 North	06.46 W.	15.21 W.

	H.	K.	F. of 5 Feet.	C.	Wind and Weather.
Afternoon.	2	5	7	SW by S.	N.E.
	4	7	——		*Set Main Top-Sail.*
	6	6	1		NE. by N.
	8	5	——		
	10	5	2	SWbyW.	N.E.
	12	4	3	S.W.	N.E. Rain
After Midnight.	2	5	5		North Rain
	4	6	3		NW by N. *Set Fore-Top-ſail*
	6	6	1		
	8	6	2		North
	10	6	——	SWbS½W	N.N.E.
	12	6	——		

Sum is 69 —— 4 Which doubled is Min. 138.8 Tenths

Month Days.	*Week Days.*	*Month and Year.*	*Courſe.*	*Diſtance ſailed in Minutes.*	*Diff. Lat. in Min.*	
					N.	S.
28	☽	Jan. 1760.	swbs½w	137.9	——	104.2

⊙ The 27th of *January*, 1760, cloſe Weather, with ſome Rain, freſh Gales, and variable; with a great Sea from the N.N.E.

About 8 this Morning we ſaw a Sail on our Larboard Quarter, ſo far off that we could but juſt diſcern her.

Our Courſe and Diſtance made good this 24 Hours, is S. 40d. 57m. W. or SW. by S. half W. 138 Min. with Latitude, Meridional Diſtance, and Longitude, as hereunder.

	d. m.		d. m.	
⊙ *Zenith Diſtance* —		⊙ *Magnet. Amplitude*	42.01	ES.
⊙ *Declination* —		⊙ *True Amplitude* —	25.46	ES.
Lat. by Obſervation—		*Variation* —	16.15	W.

Depart. in Min.		*Latitude by Account in deg. and min.*	*Meridional Diſtance in deg. and min.*	*Longitude by Account in deg. and min.*
E.	W.			
—	90.4	43.20 North	08.16 W.	17.27 W.

Afternoon

	H.	K.	F. of 5 Feet.	C.	Wind and Weather.
Afternoon.	2	5	3	S.S.W.	N.N.E.
	4	5	——		
	6	4	3		
	8	5	3		N. by E.
	10	6	2		Rain
	12	5	5		Rain
After Midnight.	2	5	——		
	4	5	——		N. by W. Rain
	6	5	3		Rain
	8	5	——		Rain
	10	5	3		
	12	4	8		

Sum is 62——0 Which doubled is Min. 124

Month Days.	*Week Days.*	*Month and Year.*	*Courſe.*	*Diſtance ſailed in Minutes.*	*Diff. of Lat. in Min.*	
					N.	S.
29	♂	Jan. 1760.	S.S.W.	124		114.6

☽ The 28th of *January*, 1760, clear Weather, intermixt with ſmall Showers of Rain, freſh Gales, and a great Sea from the N.N.E.

About 6 this Morning we ſaw two Sail on our Larboard-bow, which we judged were *French Men af War*, who chaſed us till Sun-ſet, and could not get upon us; then they lay by, ſo we loſt ſight of them.

Our Courſe is S.S.W. 124 Minutes, with Latitude, Meridional Diſtance, and Longitude, as *per Columns*, hereunder.

	d. m.		d. m.
☉ *Zenith Diſtance*	——	☉ *Magnet. Amplitude*	——
☉ *Declination*	——	○ *True Amplitude*	——
Latitude by Obſervation		*Variation*	——

Depart. in Min.		*Latitude by Account in deg. and min.*	*Meridional Diſtance in deg. and min.*	*Longitude by Account in deg. and min.*
E.	W.			
	47.4	41.25 North	09.03 Weſt	18.32 Weſt

Afternoon

	H.	K.	F. of 5 Feet.	C.	Wind and Weather.
Afternoon.	2	4	3	South	N.
	4	4	2		*Split Main Top-ſail Brought another Too.*
	6	5	—		
	8	5	2		N.N.E.
	10	5	6		Rai
	12	5	7		N. by E.
After Midnight.	2	5	5		Rai
	4	4	7		N.N.E. Rai
	6	5	3		
	8	6	1		N.E. by N.
	10	6	5		
	12	6	6		

Sum is 64 —— 7 Which doubled is Min. 129.4

Month Days.	Week Days.	*Month and Year.*	*Courſe.*	*Diſtance ſailed in Minutes.*	*Diff. of Lat. in Min*	
					N.	S.
30	☿	Jan. 1760.	South	129.4		129.4

♂ Th

♂ The 29th of *January*, 1760, freſh Gales, uncer- ain Weather, and a N.N.E. Sea after us.

Yeſterday, about three in the Afternoon, in letting the Reef out of the Main Top-ſail, it ſplit, which we unbent, and brought another Too immediately.

Our Courſe is South 129 Minutes, with Latitude, Meridional Diſtance, and Longitude as hereunder.

	d. m.		d. m:
⊙ *Zenith Diſtance*	——	⊙ *Mag. Amplitude*	——
⊙ *Declination*	——	⊙ *True Amplitude*	——
Lat.by Obſervation	——	*Variation*	——

Depart. in Min.		*Latitude by Account in deg. and min.*	*Meridional Diſtance in deg. and min.*	*Longitude by Account in deg. and min.*
E.	W.			
		39.16 North	09.03 W.	18.32 W.

	H.	K.	F. of 5 Feet.	C.	Wind and Weather.
Afternoon.	2	6	1	South	N. N. E.
	4	6	3		
	6	6	—		
	8	6	2		Rain
	10	6	5		E. N. E.
	12	6	2		N.E. by N. Rain
After Midnight.	2	6	3		E. N. E. Rain
	4	6	—		N. by E. and N. by W.
	6	5	—		N. by E. and E.N.E. Rain
	8	5	5		
	10	5	8		N.E. by N.
	12	5	7		

Sum is 71 — 6 ———— Which doubled is 143.2

Month Days.	*Week Days.*	*Month and Year.*	*Courſe.*	*Diſtance ſailed in Minutes.*	*Diff. Lat. in Min.*	
					N.	S.
31	♃	Jan. 1760.	South	143.2		143.2
		Correction by Obſervation.				34.0
		Corrected.				177.2

☿ T

☿ The 30th of *January*, 1760. Freſh Gales with ſmall Showers of Rain, a great Sea from the N.N.E.

Since the 27th Inſtant (the laſt Day of Obſervation) to this Day, I find we are more Southerly 34 minutes than by Account; and (with reſpect to the Sea) more Weſterly 14 Minutes in Meridian Diſtance, which makes very near 17 Minutes in Longitude.

Our Courſe and Diſtance corrected by a good Obſervation, is S. 4d. 33m. W. or S. half W. 177.5 Minutes, with Latitude, Meridional Diſtance, and Longitude as here-under.

	d. m.		d.m.
⊙ *Zenith Diſtance*	53.47 S.	⊙ *Mag. Ampl.*	09.07 WS.
⊙ *Declination*——	17.28 S.	⊙ *True Ampl.*	22.57 WS.
Lat. by Obſervation	36.19 N.	*Variation* ——	13.50 W.

Depart. in Min.		*Latitude by Account in deg. and min.*	*Meridional Diſtance in deg. and min.*	*Longitude by Account in deg. and min.*
E.	W.			
		36.53 N.	09.03 W.	18.32 W.
	14.8	00.34 S.	00.14 W.	00.17 W.
	14.8	36.19 N.	09.17 W.	18.49 W.

The

The Explanation of the preceding Journal

IN this Journal, in the upper Part repreſenting the Log Book, there are five Columns, and in the lower part there are twelve Columns; all which have been deſcribed in the Directions immediately before the Journal (in page 266.) The Buſineſs now is to explain the Manner of proceeding in this Journal, and that is thus; The firſt Page of the Journal (in Page 274) contains the Log-Board for the firſt Day after our departing the *Lizard*, which was ♃ the 24th of *January*, 1760, at Noon, the *Lizard* bore N. 18 Minutes Diſtance, &c. as in the Journal (Page 275) you may ſee.

But becauſe the Week Day is expreſſed by a Character, which may not be underſtood by every one (tho' it's convenient ſo to write them) you have here the Week-Days with their Characters.

Sunday	☉
Monday	☾
Tueſday	♂
Wedneſday	☿
Thurſday	♃
Friday	♀
Saturday	♄

And becauſe the *Lizard* did bear North 18 Minutes Diſtance, therefore make the Courſe South, and place 18m. in the Column, under Diſtance, &c then the Difference of Latitude is 18m. which accordingly place in the South Column, and ſubtract it from the *Lizard* Lat. 49d. 57m. the Remainder 49d. 39m. is the Lat. the Ship is in, at parting ſight of Land; which accordingly is placed in the Column, under Lat. by Account, &c. And in the laſt Column becauſe the Courſe is South, place the Longitude of the *Lizard* 5d. 14m. Weſt, and all that Day's Work is done

Then from the 24th Day at Noon, to the 25th Day at Noon, you have the Courſes and Diſtances for every two Hours, with the Wind and Weather, as they are taken from the Log-Board; and all other Circumſtances attending, are there expreſſed; for the Particulars whereof, I refer to the Journal it ſelf, in page 274. The ſeveral Courſes and Diſtances of this Day, may be reduced to three Courſes; Thus, *The Work of ♃ the 24th of* January, 1760, *being the firſt Day's Sailing, in the preceding Journal, page* 274.

H.		K.F.
At 4	W SW.	5.0
6	The ſame	5.6
8	The ſame	5.5
12	The ſame	6.5
2	The ſame	6.1
4	The ſame	6.1
6	The ſame	6.3
10	The ſame	6.0
12	The ſame	6.0
	Sum'd up is	53.1
	That is W S W Min.	106.2

H.		K.F.
At 2	W by N.	5.2
	That is WbyN.	10.4
At 10	SW by W.	5.5
8	The ſame	6
	Sum'd up is	11.5
	That is, S W by W. 23 Min.	

Courſe.	*Diſt.*	N.	S.	E	W
W S W	106.2		40.7		98.2
W by N	10.4	2.1			10.2
SW by W	23.0		12.8		10.1
Diſtance	139.6		53.5	*Dep.*	127.5
			2.1		

Difference of Latitude 51.4

As Diff. Lat. .. Dep. : : Radius .. T. Courſe.
As m. 51 $\frac{4}{10}$ .. m. 127$\frac{5}{10}$: : T. 45d .. T 68° 3 '(SW)yorWSW.
Then, As Sine Courſe .. Depart. : : Radius .. Diſtance.
As S. 68d. 03m. .. m. 127.5 : : S. 90d. .. m. 137.4

So that the Courſe made good, is S. 68d. 03m. Weſterly; or WSW. neareſt, and the Diſtance 137 Min. 4 Tenths; which place in their proper Columns, as may be ſeen in the firſt Day of the *Journal*, at the Foot thereof in page 274.

The Difference of Latitude m. 51 $\frac{4}{10}$ (or neareſt 51 Min.) being Southerly, ſubtract from 49d. 39m. the Latitude at parting Sight of Land, the Remainder 48d. 48m. place under Latitude by Account, for the Latitude the Ship is now in.

Again, the Departure 127.5 Minutes being reduced into Degrees makes 2d. 7m. Weſterly, which place in the Column under Meridian Diſtance, *&c.* in page 275.

Laſtly, To find the Longitude the Ship is now in, you have both Latitudes 49d. 39m. and 48d. 48m. the preſent Latitude, and the Latitude of the Day before, with the Departure min. 127.5, by which find the Difference of Longitude as directed in *Problem* 5. of *Mercator's* Sailing, in pages 96 and 97, where the Proportion is,

As the Difference of Latitude, is to the Departure, ſo is the Meridional Difference of Latitude, to the Difference of Longit.

		d. m.		Min.	
♃ 24	Lat.	49.39	Merid. Parts	3442	found in the Table
♀ 25		48.48		3364	of Merid. Parts.

The Meridional Difference of Latitude 78 Then ſay,

As 51m $\frac{4}{10}$ .. m. 127 $\frac{5}{10}$: : m. 78 .. 193.5m. or 3d. 13m. W. erly, which being added to the Longitude of the Day before 5d. 14m. the Sum 8d. 27m. Weſt, is the preſent Longitude, which place in the laſt Column of the *Jourual*; then that Day's Work is finiſh'd.

Then from the 25th Day at Noon, to the 26th Day at Noon (in the two next Pages of the *Journal*) the Courſes and Diſtances for every two Hours, the Wind and Weather, with other Circumſtances attending, taken from the *Log-Board*, are ſet down; for the Particulars, ſee the *Journal* in pages 276 and 277.

Now the ſeveral Courſes and Diſtances of this Day are reduced thus;

The Work of ♀ *the 25th of* January, 1760, *the ſecond Day's Sailing in the preceding* Journal, *in Pages* 276 *and* 277.

H.		K. F.
Firſt, 2	WSW.	6
10	The ſame	7
12	——	7.1
2	——	7.
6	——	7.2
8		7.
10	——	6.2
12	——	6.6
Summed up, is		54 1
That is WSW.		108.2

H.		K. F.
Secondly, 4	—— SW.	6.
6	— The ſame	5.8.
Summed up, is		11.8
That is S W.		23.6
Thirdly, 8	SW by W.	7 1
4	The ſame	6.8
Summed up, is		13.9
That is SW. by W.		27 8

So that the Courſes of this Day are theſe, WSW. m. 108.2 SW. m. 23.6, and SW. by W. m. 27.8, and by *Chapter* 3. *Section* 4 of *Plane-Sailing*, in Pages 64 and 65, may be reduced into on Courſe as follows

Courſes.	*Diſt.*	N.	S.	E.	W.
W.S W.	108.2		41.5		100 0
S. W.	23 6		16.7		16.7
S.W. by W.	27.8		15.4		23.1
Diſtance.	159.6	*Lat.*	73.6	*Dep.*	139.8

As Diff. Lat. ·· Dep. : : Radius ·· T. Courſe.
As m. 73.6 ·· m. 139.8 : : T. 45d. ·· T. 62d 14m. South Weſterly, or SW. by W. ½ W. is the Courſe made good.
As S. Courſe ·· Departure : : Radius ·· Diſtance.
As 62d. 14m. ·· m. 139.8 : : S. 90d. ·· 158 Minutes.

The Difference of Latitude m. 73.6 S. and the Depart. m. 139 8 Weſt, make the Courſe S. 62d 14m W. or S.W. by W. ½ W. an the Diſtance 158 Min. which place in their reſpective Columns in the Journal for the Day propoſed, in pages 276 and 277.

Then the Difference of Latitude m. 73.6 or 1d. 14m. being ſubtracted from the Latitude the Day before, 48d. 48m. the Remainder 47d 34m. place under Latitude by Account, for the Latitude the Ship is now in, as in page 277.

And the Departure m. 139.8 near 140 Minutes, being equal to 2d. 20m. is added to (becauſe it's Weſt, had it been Eaſt it ſhould have been ſubtracted from) 2d. 7m. the Meridian Diſtance the Day before, and it makes 4d. 27m. Weſt, for the Ships whole Meridian Diſtance from the *Lizard*, which place under it's proper Title, in Page 277.

Laſtly, To find the Longitude the Ship is now in, you have the Latitude 48d. 48m. and 47d. 34m. the preſent Latitude, and the Latitude of the Day before, with the Departure m. 139.8, by which you may find the Difference of Longitude in this manner.

		d. m.		Min.	
♀ 25	Lat.	48.48	Mer. Parts	3364	found in the Table of
♄ 26		47.34		3253	Meridional Parts.

The Merid. Differ. of Latitude 11 , And then ſay,

As m.73.6 ·· m.139.8 : : m.111 ·· m.210 $\frac{8}{10}$, or 3d. 31m. Weſterly, which being added to the Longitude of the Day before, 8d. 27m. the Sum 11d. 58m. Weſt, is the preſent Longitude, which place in the laſt Column of the Journal, in page 277 ; and the ſecond Days Work is finiſhed.

Again, In the two next pages of the Journal, are the Courſes Diſtances, Winds, &c. taken off the Log Board from the 26th Day at Noon, to the 27th, which are wrought as follows.

The Work of ♄ *the* 26*th of* January, 1760, *the third Days Sailing in the preceding* Journal

Courſes.	*Diſt.*	N.	S.	E.	W.
S. W by W.	12.6		7.0		10.5
S. W. ——	168.2		118.9		118.9
Diſtance	180.8	*DiffLat.*	125.9	*Dep.*	129.4

As Diff. Lat. ·· Departure : : Radius ·· T. Courſe.

As m. 125.9 ·· m. 129.4 : : T. 45d. ·· T. 45d. 47m. South Weſterly or SW. is the Ships Courſe

As S. Courſe ·· Departure : : Radius ·· Diſtance.

As S. 45d. 47m. ·· m 129.4 : : S. 90d. ·· 180 5 Minutes.

By the Work above it's evident that the Difference of Latitude is m. 125.9 South, the Departure m. 129 4 Weſt, which makes the Courſe S. 45d. 47m. W. or SW. and the Diſtance 80.5 Minutes very near, which place in the reſpective Columns, in the Journal for ☉ the 27th of *January*, in pages 278 and 279.

Then the Difference of Latitude m. 125.9 or near 125 Minutes, equal to 2d. 6m. South, ſubtracted from the Latitude of the Day before, 47d. 34m. Remainder is the Latitude by Account, the Ship is in 45d. 28m N. which place in the 10th Column, in page 279.

And the Departure 129 min. or 2d 9m. Weſt, being added to 4d. 27m. the Meridian Diſtance of the Day before, makes 6d. 36m. Weſt, the whole Meridian Diſtance by Account from the *Lizard*, which place in the 11th Column of the Journal, in page 279.

And now having both Latit 47d 34m. and 45d. 28m. with the Departure m. 129.4; by them find the Diff. of Long. thus,

♄ 26	Lat.	47d. 34m.	Merid. Parts	3253	Min	found in the Table of Merid. Parts.
☉ 27		45d 28m.		3069		

The Meridional Difference of Latitude 184 Min.

As m. 125.9 .. m. 129.4 : : 184m. .. 189.1m. or 3d. 9m. Weſt, the Difference of Longitude, and being added to the Longitude of the Day before, 11d. 58m. the Sum 15d. 07m. is the Longitude (by Account) the Ship is now in; which place in the laſt Column of the Journal, in page 279; and this Day's Work (as to the Account, or Dead Reckoning) is finiſhed.

But on the ſaid 27th of *January* at Noon, by a good Obſervation of the Sun, I find the Latitude 45d. 4m. North, whereas by the Journal, the Latitude is 45d. 28m. North, their Difference is 24m. South, that is, the Ship by Obſervation is 24 Minutes more Southerly than by the Reckoning.

Wherefore to correct the Latitude, place 24m. in the South Column, and add it to the Difference of Latitude m. 125.9, it makes min. 149.9 for the corrected Difference of Latitude; alſo ſubtract it from 45d. 28m. (the Latitude by Account) to make it agree with the Obſervation, as you ſee is done in the Journal for the ſaid 27th Day, in pages 278 and 279.

Then to correct the Departure, conſider according to the 9th Rule in the Directions for keeping a Journal, preceding it in page 269, whether there be a Current or no, and conſulting the written Journal, I find, "*A great Sea after us, ſetting towards the* SSW. "*for theſe three Days paſt*"; which I take to be the Cauſe of this Error of 24m. in the Reckoning Latitude; and therefore (by Problem 2, of Plane Sailing, in page 61.) find what Departure a SSW. Courſe, with Difference of Latitude 24m. will make, which is thus,

As S. 6 Points .. 24m. : : S. 2 Points .. m. 9.941 the Correction in the Departure, which place in the Weſt Column, and add it to the Departure m. 129.4, it makes 139.3. for the corrected Departure: Alſo add it to 6d. 36m. (the Meridian Diſtance by Account) it makes 6d. 46m. the corrected Meridian Diſtance; as you ſee in the 11th Column of the Journal in page 279: And to correct the Longitude by the 17th Rule for keeping a Journal (in pages 270 and 271) is thus:

		d. m.		min.	
Lat. by	Account	45.28	Mer. Parts	3069	found in the T.
	Obſerv.	45.04		3036	of Merid. Parts.
Correction in Lat.	—	24	Mer. Diff. Latit.	33	Then,

As 24m. .. m. 9.941 : : 33 Min. .. 13.67 Min. the Correction in Longitude Weſt; which being placed in the laſt Column, and added (for that by the Second of the 13th Rule preceding the Journal, in page 270, the Ship hath out-run the

Reckoning) to 15 deg. 07 min. the Longitude over it, the Sum 15d. 21m. write underneath, which is the corrected Longitude the Ship is in.

Laſtly, To find the Courſe and Diſtance agreeable to the Correction by Obſervation, you have the corrected Difference of Latitude and Departure; which according to Problem 6. of *Plane-Sailing*, in page 63, is thus:

As the corrected Difference of Latitude, is to the corrected Departure; ſo is Radius, to the Tangent of the Courſe corrected. That is,

As m. 149.9 .. m. 139.3 : : T. 45d. .. T. 42d. 54m. South weſterly, or SW. by S. three quarters W. is the corrected Courſe.

As S. Courſe .. Depart. : : Radius .. Diſtance.

As S. 42d. 54m. .. m. 139.3 : : S. 90d. .. 204.6 m. cor. Diſt.

So that the Courſe and Diſtance corrected by Obſervation is SW. by S. three quarters W. 205 Minutes nearly, which write in the Journal for the ſaid Day, in page 279. Then the whole is finiſhed, and the Reckoning ſet to Rights for that Time.

And now, having largely ſhewed the Manner of theſe three Days Sailing, how they are wrought, and placed in their proper Columns in the Journal, with an Example of a Correction by Cœleſtial Obſervation; I leave the reſt to the diligent Learner's Practice, for they are done after the ſame Manner: And the 31ſt of *January* you'll meet with another Correction for your Trial, which you may perform, if you ſtudiouſly compare this one Example with the preceding Rules and Directions, and with frequent Practice theſe will ſufficiently enlighten the Way, the Manner how, and the Means whereby, to keep a Journal (in this eaſy and commodious new Method) with greater Certainty than hath hitherto been taught.

And to invite all to keep their Sea Journals after this new Method, which I dare preſume will nearly quadrate with the Forms practiced by the Ingenious; I have cauſed Paper Books to be ruled and intitled (in all Reſpects) like to the Journal foregoing.

Which you may be furniſhed with at reaſonable Rates, by *W.* and *J. Mount*, *T. Page* and *Son*, in *Poſtern-Row* on *Tower-Hill.*

Here follow ſeveral TABLES *uſeful in Navigation, with their Deſcription and Uſes briefly and fully explained.*

I. A Table of the Difference of Latitude and Departure from the Meridian.

II. A Table of Meridional Parts, for the making *Mercator's Charts*, and working Queſtions in that kind of Sailing.

III. A Table of Proportional Parts, for ſupplying every Minute of Latitude in the Table of Meridional Parts.

IV. A Table of Logarithms from 1 to 10 000.

V. A Table of *Artificial Sines*, *Tangents*, and *Secants* to every *Degree and Minute of the Quadrant*, the *Radius* being 10.000000.

VI. A Table of *Angles*, which every Rhumb (or Point of the Compaſs) maketh with the Meridian.

All of them carefully Corrected and exactly Printed.

Chap. I. *The Explanation, and general Uſe of the Table of Logarithms, and Table of Sines, Tangents and Secants.*

THE Table of *Logarithms* being of more general Uſe than any other, I begin with it, although it be one of the laſt in this Book.

Section I. *The Uſe of the Table of* Ten Thouſand Logarithms, beginning at Page 315.

THIS *Table* hath its firſt Page divided into ſix Columns, and all the following Pages into ſeven Colums, and containeth the Logarithms for all Numbers, increaſing in their Natural Order, from 1, to 10.000; after this Manner.

1. The *Firſt*, *Third* and *Fifth* Colums of Page 315, contain Numbers, encreaſing in their Natural Order, from 1 to 100, the other three Columns contain the *Logarithms* of them.

2. The Left-hand Column of each following *page* (from *page* 316 to *page* 357) contains Numbers encreaſing as before, from 100, to 999; the next five Columns of each page, contain the Logarithms of all Numbers from 1000, to 9999: Thoſe on the Left-hand page are diſtinguiſhed at the Top with the Figures 0|1|2|3|4, thoſe on the Right-hand with theſe Figures, 5|6|7|8|9

3. The Numbers in the Left-hand Column, (under *Numb.*) in each page, with the joining thoſe Figures at the Top of the other Ten Columns are extended from 1000 to 9999.

4. The laſt Column of each page under *Diff.* at the Top, containeth the Difference of the Logarithms ſucceſſively in that Column.

The Manner of Reading them, and their general Uſe, ſhall be explained in the following Propoſitions.

Propoſition 1. *A whole Number under* 100, *being given; to find the Logarithm thereof.*

The Rule. Turn to the Table of Logarithms, and in the Firſt, Third, or Fifth Column, of page 315, under *(Numb.)* at the Top, look for the given Number, and in the next Column under *(Logar.)* is the Logarithm ſought.

Example. *Suppoſe the given Number was* 19; *What is it's Logarithm?*

Look in the firſt Column of page 315, under *(Num.)* for 19, and in the next Column, under *(Logar.)* is 1.278754, which is the Logarithm of 19: After the ſame Manner you will find the

Logarithm of	to be
2	0.301030
10	1.000000
45	1.653212
100	2.000000

Note 1. In every Logarithm, the firſt Figure or Index (to the Left-hand, is called the Characteriſtic, Index, or Noting Figure, and it ſerveth to ſhew how many Places the Abſolute or Natural Number, (thereunto belonging) doth contain.

Note 2. The Characteriſtic or Index of every Logarithm, is an Unit leſs than the Number of Places in its correſpondent abſolute Number. That is,

All Numbers from 1 to 10, the firſt Figure of their Logarithms is 0, from 10 to 100, is 1; from 100 to 1000 is 2; from 1000 to 10.000 is 3; from 10.000 to 100.000, the Characteriſtic or Index, of their Logarithm is 4, *&c.*

Propoſition 2. *A Number that conſiſts of three Places, being given; to find its* Logarithm.

The Rule. Seek the given Number in the firſt Column, of the Left-hand Page under *(Num.)* at the Top; juſt againſt that Number, and in the next Column under (0) at the Top, you will find a Number of 6 Places beſides the Index Figure correſpondent to the given Number; that intire Number is the Logarithm ſought.

Example. *I deſire to know the* Logarithm *belonging to the Abſolute Number* 215?

In the firſt Column of page 320 under *(Num.)* you'll find 215, and right againſt it in the next Column under (0) at the Top, is .332438, beſides 2 the Index Figure proper for 215, the intire Logarithm is 2.332438, for the Number 215.

In like Manner the Logarithm of	is	
21.5	1.332438	
2.15	0.332438	
0.215	$\bar{1}$.332438	
0.369	$\bar{1}$ 567026	in Page 328
3.69	0.567026	
36.9	1.567026	
369.	2.567026	

Here Note, That when the given Number is a Decimal Fraction, the Index hath a Daſh over it, which by ſome is called a Negative, being it's the Index of a Logarithm whoſe correſpondent Abſolute Number is leſs than an Unit.

Propoſition 3. *A Number conſiſting of four Places given; to find the* Logarithm *thereof.*

The Rule. Seek the three firſt Figures of the given Number in the Left-hand Column, under (*Num.*) and the Fourth or laſt Figure at the Top; then in the Common Angle of Meeting is a Number or ſix Places (beſides the Index Figure) before which, if you place or prefix its proper Characteriſtic or Index, you'll then have the Logarithm ſought.

Example. *What is the* Logarithm *of* 2157?

In the Left-hand Column of Page (320) under (*Num.*) find 215, and 7 at the Top of page (321) then right againſt (215) and under 7 you'll find (beſides its Index Figure) .333850; before which prefix its proper Index 3, and it's 3.333850, the Logarithm of 2157. In like Manner,

The Logarithm of	is	
215.7	2.333850	
21.57	1.333850	
2.157	0.333850	
0.2157	$\bar{1}.333850$	
0.02157	$\bar{2}.333850$	
0.002157	$\bar{3}.333850$	
0.03695	$\bar{2}.567614$	In Page 329.
0.3695	$\bar{1}.567614$	
3.695	0.567614	
36.95	1.567614	
369.5	2.567614	

Propoſition 4. *A* Logarithm *being given to find the Abſolute Number thereunto belonging.*

This is but the Converſe of the former Propoſitions, and therefore according to Chapter 1. *Note* 2. in page 295.

The Rule is, 1. The Characteriſtic or Index, will declare of how many Places the Correſpondent *Abſolute Number* doth conſiſt.

2. For if the Index be (0) or (1) ſeek the given Logarithm in page 315, of the Table of Logarithmns; and when it's (2) ſeek it in the following pages after page 315. But when it's 3, 4, or 5, *&c.* reject the Index and ſeek the remaining Figures among the Logarithms as before, and the Number againſt it is the Number ſought.

Example. *Let the given Logarithm be* 0.698970. *What is the Abſolute Number belonging thereunto?*

This Logarithm 0.698970 ,you will find in the ſecond Column of Page 315, under *(Logar.)* at the Top, and right againſt it in the Left-hand Column under *(Num.)* there is (5) which is the Abſolute Number ſought.

Example 2. *I demand the Abſolute Number Correſpondent to this* Logarithm 1.653212?

Look down the fourth Column of Page 315, and you'll find 1.653212 under *(Logar.)* to ſtand againſt 45 under *(Num.)* which is the Number required.

Example 3. *What is the abſolute Number anſwerable to this* Logarithm 2.332438?

The Characteriſtic or Index 2, ſheweth the Number ſought doth conſiſt of three Places; and in the ſecond Column of the Left-hand Page under (0) at the Top, in Page (320) you will find the aforeſaid Figures 2.332438 to ſtand againſt (215) in the firſt Column under *(Num.)* therefore the given Number ſought is 215.

Example 4. *Suppoſe the given* Logarithm *be* 3.333850; *What is the Abſolute Number agreeable thereunto?*

Reject 3 the Index, which declareth the Number ſought conſiſts of four Places: and then looking down the ſecond Column of the Left-hand Page, you will in Page (320) find the neareſt, (leſs than .333850 the given Logarithm,) to be .332438, and the Number againſt it in the Left-hand Column is (215); then look a-croſs the Pages in the ſame Line direct, towards the Right-hand, from the ſaid 215, and under 7 at the Top in Page (321) you will find the given Logarithm .333850, therefore 215 in the Left-hand Column, and the 7 at the Top being put together, make 2157 the Number required.

Section II. *The Uſe of the* Table *of* Artifical Sines, Tangents, *and* Secants, *beginning in* Page 358.

THIS Table followeth next after the Table of *Logarithms*, and contains the *Logarithmic Sine*, *Tangent*, and *Secant* to every Degree and Minute of the Quadrant, after this manner.

1. Every Page is divided into 8 Columns, the firſt and laſt of which contain the Minutes of every Degree, and the other 6, the Logarithmic Sine, Tangent and Secant to thoſe Degrees and Minutes.

2. The $\left\{\begin{matrix}\text{Left-}\\\text{Right-}\end{matrix}\right\}$ hand Column of each Page $\left\{\begin{matrix}\text{under}\\\text{over}\end{matrix}\right\}$ *Min.* at the $\left\{\begin{matrix}\text{Head}\\\text{Foot}\end{matrix}\right\}$ of the Table containeth the Minutes of thoſe Degrees which are $\left\{\begin{matrix}\text{leſs}\\\text{more}\end{matrix}\right\}$ than 45, and increaſe in their $\left\{\begin{matrix}\text{Deſcent}\\\text{Aſcent}\end{matrix}\right\}$ from 0 to 60 Minutes.

The Explanation is in the Propoſitions following.

Propoſition 5. *To find the* Sine, Tangent, *and* Secant *of any Degree and Minute given.*

The Rule. If the Degree be $\left\{\begin{matrix}\text{leſs}\\\text{more}\end{matrix}\right\}$ than 45, its found in thoſe Columns which have the Words, *Sine*, *Tangent*, *Secant*, at the $\left\{\begin{matrix}\text{Head}\\\text{Foot}\end{matrix}\right\}$ of the Table.

Example 1. *I demand the* Sine, Tangent, *and* Secant *of* 25d. 15m.

Look for 25 Degrress (in page 408) at the Head or Top of the Table, in the firſt Column (of the Left-hand Page) under *(Min.)* at the Top, look downward for 15; againſt which, and (in page 408) under *(Sine)* you will find 9.629989, which is the Sine of 25d. 15m. Alſo againſt 15, and under *Tang.* you have 9.673602, the Tangent of 25d. 15m. Likewiſe againſt 15, and under *Secant*, you have 10.043613, the *Secant* of 25d. 15m.

Example 2. *Suppoſe you are to find the* Sine, Tangent *or* Secant *of* 33d. 45m.

Turn to 33 Degrees (in page 424) at the Head of the Table, and in the firſt Column upon the Right-hand Page, under *(Min.)* at the Top (of page 425) find 45; right againſt which, and under *(Sine)* at the Head of the Table (in page 425) you will find 9.744739, which is the Sine of 33d..45m. Alſo againſt 45, and under *(Tang.)* you'll have 9.824893, the Tangent of 33d. 45m. Likewiſe againſt 45, and under *(Secant)* is 10.080154, the Secant of 33d. 45m.

Example 3. *Let it be required to find the* Sine, Tangent, *or* Secant *of* 56d. 15m.

Seek 56 Degrees (in page 425) at the Foot or Bottom) of the Table, and in the Right-hand Column of (page 425) over *(Min.)* at the Foot of the Table look upwards for 15; then

hen againſt 15, and over *Sine* (at the Foot of the Table) you ave 9.919846, the Sine of 56d. 15m. Alſo, againſt 15, and ver *(Tang.)* you will find 10.175107, the Tangent of 56d, 15m. Likewiſe againſt 15, and over *(Secant)* you'll find 10.255261 the Secant of 56d 15m.

Example 4. *Suppoſe it were required to find the* Sine, Tangent *or* ecant *of* 67d. 51m.

Turn to 67 Degrees at the Foot of the Table, in *(page* 402.) nd in the Right-hand Column of that page over *Min.* at the Foot f the Table, look upwards for 51; then againſt 51, and over Sine in *page* 402.) you'll find the Sine of 67d. 51m. to be .966705; and the Tangent in the ſame Line, over *(Tang.)* to e 10.390326; alſo the Secant to be 10.423621.

Propoſition 6. *A* Sine, Tangent, *or* Secant *being given; to find the Degrees and Minutes anſwering thereto.*

And that the Learner may the more readily turn to the Degree nd Minute required, let him obſerve this brief Rule.

$$\left\{\begin{array}{l}\text{Sine}\\ \text{Tang.}\\ \text{Secant}\end{array}\right\}\text{and the 1ſt Figures}\left\{\begin{array}{l}\text{leſs}\\ \text{more}\end{array}\right\}\text{than}\left\{\begin{array}{l}9.8494\\ 10.0000\\ 10.1505\end{array}\right\}$$

$$\text{is a}\left\{\begin{array}{l}\left.\begin{array}{l}\text{Sine}\\ \text{Tang.}\end{array}\right\}\text{leſs}\\ \text{Secant more}\end{array}\right\}\text{than 45 Degrees.}$$

Example 1. *Suppoſe it was required to find the Degrees and Mi-utes anſwering to this* Sine, 9.739205.

This according to the preceding Rule, being the Sine of leſs ian 45 Degrees, I run over the Columns which have *(Sine)* at ie Head of the Table, and under 33 Degrees, and againſt 16, n *page* 424) I find the given Sine; therefore the Degrees and Minutes ſought are 33d. 16m.

Example 2. *Suppoſe you are to find the Degrees and Minutes rreſpondent to this Tangent* 10.183966.

Running over the Columns which have *(Tang.)* at the Foot of ie Table, you'll (in *page* 424) over 56 Degrees, and right againſt 7 *(Min)* the neareſt leſs to be 10.183893. Therefore the neareſt orreſponding Degree and Minute is 56d. 47m. In like Manner for any other.

Propoſition 7. *To find the* Sine Complement, Tangent Com-lement, *or* Secant Complement *of any* Degrees *and* Minutes.

The Rule. Subtract thoſe Degrees and Minutes from 90 De-rees, and then take the Sine, Tangent, or Secant of the Re-

Remainder according to Propoſition 5. in page 298 ; which will b the Sine Complement, Tangent Complement, or Secant Complement required.

Example. *Suppoſe it be required to find the Sine Complemen Tangent Complement, or Secant Complement of* 33d. 45m.

Subtract 33d. 45m. from 90d Degrees, the Remainder is 56 15m. whoſe Sine, Tangent, or Secant, according to Propoſition 5 in page 298, is the Sine Complement, Tangent Complement, o Secant Complement required.

Propoſition 8. *To find the* Sine, Tangent, *or* Secant *of any Number of* Degrees *and* Minutes *which exceed* 90 *Degrees.*

The Rule. Subtract thoſe Degrees and Minutes from 180 Degrees, and ſeek (according to Propoſition 5, in page 298) the Sine Tangent, or Secant, of the Remainder, which will be the Sine Tangent, or Secant required.

Example. *Suppoſe you are to find the* Sine *of* 132d. 17m.

Subtract 132d. 17m. from 180 Degrees, the Remainder 47d. 43m. the Sine of which is the Sine required.

Propoſition 9. *To find the Complement Arithmetic of any Logarith given.*

The Complement Arithmetic of a Logarithm is, what wanteth of 10.000000 or 20.000000, and is uſed to avoid Subtraction; For finding it, this is,

The Rule. Take the Reſidue or Remainder, of the firſt Figu to 9, and ſo of the reſt, until you come to the laſt Figure, which take its Remainder under 10, and it's done.

Example 1. *I would have the Compl. Arithmetic of* 9.625948

For the firſt Figure 9 write 0; for 6, 3; for 2, 7; for 5, 4 for 9, 0; for 4, 5; and for the laſt Figure 8, write 2: And you have 0.374052, for the Complement Arithmetic ſought.

Example 2. *The* Complement Arithmetic *of* 10.331327 *is r quired?*

For 0 (always rejecting the firſt Figure, when there are tw Figures in the Characteriſtic) write 9; and ſo on as before d rected, and then you will have 9.668673, which is the Complement Arithmetic of 10.331327.

CHA

CHAPTER II. *The Explanation and Uſe of the Table of Difference of Latitude and Departure from the Meridian, in Page 306 and 307.*

THIS Table, tho' ſtanding in ſo litte Room as two Pages, will give the Difference of Latitude and Departure for any Diſtance un, under 10.000; and for every Quarter Point of the Compaſs.

The Courſe ſtands at the Head and Foot of the Table; at the Head it begins at ¼ Point, and then ½ Point, ¾ Point, increaſing forward to 4 Points.

At the Foot it begins at 4 Points, and then 4 ¼ Points, 4 ½ Points, 4 ¾ Points, increaſing backward to 7 ¾ Points.

The Diſtance run is placed in the two outermoſt Columns of each Page, under and over the Word Diſt. both at the Right-hand and at the Left-hand, beginning at 1; and increaſing downward to 10, about Half-way each Page; and then beginning again at 1, and from thence increaſing to 10, at the Foot of each Page.

The Difference of Latitude and Departure from the Meridian, ſtand under the Courſe at the Head of the Table, and over the Courſe at the Foot thereof; which are diſtinguiſhed by the Words *Lat.* and *Dep.*

The Uſe of this Table ſhall be made evident in reſolving a ſingle Courſe (which is the firſt Caſe of *Plane-Sailirg)* and alſo a Traverſe, in theſe following Propoſitions.

Propoſition 10. *Courſe and Diſtance run given; to find the Difference of Latitude and Departure from the Meridian?*

Example 1. *Admit a Ship ſails* S. *by* W. ¾ W. 6 *Minutes, I demand the Difference of Latitude and Departure from the Meridian?*

On the Left-hand in Page 306, (of the Table under 1 ¾ Point) and right againſt 6 Minutes under *Diſt.* you will find (under the Word *Lat.)* 5.6492, and (under the Word *Dep.)* 2.0213, for the Difference of Latitude, and Departure required.

But it may ſuffice if the Difference of Latitude and Departure be taken only in Leagues or Minutes, and tenth Parts of a Minute, or League, with this Allowance, that is,

$$\text{If the Parts be}\left\{\begin{array}{c}051\\151\\251\\351\\451\\551\\651\\751\\851\end{array}\right\}\text{or more, for it ſet down}\left\{\begin{array}{c}1\\2\\3\\4\\5\\6\\7\\8\\9\end{array}\right\}\begin{array}{l}\text{Tenth}\\ \\ \\ \\ \text{Tenths}\\ \\ \\ \\ \\ \end{array}$$

And when the Parts are 951, or more, then make the Minute or Leag. of Diff. of Lat. and Dep. from the Meridian, 1 mor than they are in the Table; as for Inſtance in both Caſes.

$$\text{Inſtead of}\left\{\begin{array}{l}3.151\\6.151\\7.259\\8.960\\9.959\end{array}\right\}\text{ſet down}\left\{\begin{array}{l}\left.\begin{array}{l}3.2\\6.2\\7.3\end{array}\right\}\text{Tenths}\\\left.\begin{array}{l}9.\\10\end{array}\right\}\text{Minutes or Leagues.}\end{array}\right.$$

So then the aforeſaid *Example* S. by W. $\frac{3}{4}$ W. Diſtance 6 min being ſought in the Table, finds as by the above.

$$\text{The}\left\{\begin{array}{l}\text{Difference of Lat. } 5.6492\\\text{Departure} \text{ ——— } 2.0213\end{array}\right\}\text{that is,}\left\{\begin{array}{l}\text{Min. } 5.6 \text{ Tenths.}\\\text{Min. } 2.0 \text{ Tenths.}\end{array}\right.$$

Example 2. *A Ship ſails* SSW. *half* W. 60 *Minutes, I deman the Difference of Latitude and Departure from the Meridian?*

To perform this, count 1, at the Beginning of the Table, t be 10, and 2 to be 20; 3, 30; 4, 40; 5, 50; 6, 60 &c. to 10 which now ſtands for 100: According to this Direction, again 6 (which now ſtands for 60) on the Right-hand page 307, an under 2 $\frac{1}{2}$ Points, ſtands 5.2915 under *Lat.* and 2.8284 unde *Dep.* which makes the Diff. of Lat. 52.915, or Min. 52.9 Tenths and the Dep. 28.284, or Min. 28.3 Tenths: For obſerve, Tha if the Diſt. be 6 Min. the Diff. of Lat is 5.291, and Dep. 2.828 rejecting the laſt Figures, which are of little Value. But,

$$\begin{array}{l}\text{If the}\\\text{Diſt. be}\end{array}\left\{\begin{array}{l}60\\600\\6000\end{array}\right\}\begin{array}{c}\text{The}\\\text{Diff. Lat.}\end{array}\left\{\begin{array}{r}52.91\\529.1\\5291.\end{array}\right\}\text{and Dep.}\left\{\begin{array}{r}28.28\\282.8\\2828.0\end{array}\right.$$

And after this Manner you muſt increaſe the Diff. of Lat. an Dep. as the Diſtance doth increaſe, in a tenfold Ratio.

Example 5. *Suppoſe a Ship ſails* ESE. $\frac{1}{4}$ E. 65m. *I demand th Difference of Latitude and Departure from the Meridian?*

This muſt be looked out of the Table at twice, that is, firſt fin the Diff. of Lat. and Dep. for Diſt. 60 Min. then find the Diff. o Lat. and Dep. for Diſt. 5 Min. both under the ſame Courſe, an add both together, which will ſhew you the Diff. of Lat. and Dep- required; as hereunder you may ſee.

$$\text{For Diſt.}\left\{\begin{array}{r}60\\\underline{5}\\65\end{array}\right\}\text{The Diff. Lat. is}\left\{\begin{array}{r}20.21\\\underline{1.68}\\21.89\end{array}\right\}\text{and Dep.}\left\{\begin{array}{r}56.49\\\underline{4.71}\\61.20\end{array}\right.$$

That is, according to the former Directions, the Difference c Latitude 21.89, or Minutes 21.9 Tenths, and the Departure 61.20 or Minutes 61.2 Tenths, which was required.

Example 4. *A Ship ſails* SW. by S. $\frac{1}{4}$ W. 137 *Minutes, I deman the* Difference *of* Latitude, *and* Departure *from the Meridian?*

Thi

This muſt be taken out at thrice; that is, ſeek the Diff. of Lat. and Dep. for the Diſt. in m. 100, for m. 30. and for m. 7, with the ſame Courſe; add them together, as hereunder is done.

	Min.		Min.		Min.
For Diſt.	100	Diff. Lat. is	80.32	and Dep.	59.57
	30		24.10		17.87
	7		5 62		4.17
	137		110.04		81.61

That is, *Differ. of Lat. is* 110 *Min. and Dep. is* m. 81.6 *Tenths.*

Propoſition 11. *Several Courſes and Diſtances given; to find the Diff. of Lat. and Depart. which is the reſolving a Traverſe.*

Example. *Admit a Ship ſails* WSW. 106.2m. *then* W. *by* N. m.10.4. *then* SW. *by* W. 23m. *I demand the Difference of Latitude and Departure, direct Courſe and Diſtance from the firſt Place?*

Theſe Courſes and Diſtances are taken from the foregoing Journal, in Page 274, being what the Log-Board made out for the firſt Day after departing from the *Lizard.*

In order to the working this by the Traverſe Table, ſet down the ſeveral Courſes, and Diſtances, as in the Table following.

Courſes.	*Diſt. in min.*	*Difference of Latitude.*		*Departure.*	
		N.	S.	E.	W.
WSW.	100.0		38.27		92.39
	6.0		2.30		5.54
	.2		.08		.18
W. by N.	10.0	1.95			9.81
	0.4	0.08			0.39
SW by W.	20.0		11.11		16.63
	3.0		1.67		2.49
Summed up		2.03	53.43		127.43
Subtracted			2.03		
		Lat.	51.40	Dep.	127.43

Then by *Prob.* 1. Find the Diff. of Lat. and Dep. for each ſeveral Courſe and Diſtance, which Place in their proper Columns; that is, if the Courſe be North Eaſterly, place the Difference of Latitude in the North Column under N. and the Departure in the Eaſt Column under E. If the Courſe be N. Weſterly, place the Difference of Latitude in the N. Column under N. and the Departure in the Weſt Column under W.

If the Courſe be South Eaſterly, place the Diff. of Lat. in the S. Column under S. and the Depart. in the Eaſt Column under E. but f the Courſe be South Weſterly, place the Difference of Latitude in the South Column, and the Departure in the W. Column.

As for Inſtance, in the foregoing Table; the firſt Courſe is WSW. the Diſtance 106.6m. which is parted into three parts, *viz.* 100 and 6 and 2; and the Courſe being S.W.erly, I place the Difference of Lat. m.38.27 under S. and the Dep. m. 92.39 under W. The like I do for the Diſtance 6, and alſo for 2, as is done for the Diſtance 100. The ſecond Courſe is W. by N. the Diſtance 10.4, which is alſo look'd out at twice; and the Diff. of Latitude 1.95, I place under N. and the Departure 9.81 under W. the like you muſt do for the reſt.

Thus having found the Difference of Lat. and Departure for all the Courſes, and inſerted their ſeveral Diff. of Lat. and Departures in their proper Columns; the next thing is, to add up the N. E. S. and W. Columns, and ſet their Sums underneath.

Then ſubtract the N. and S. Columns, the leſs from the greater; and likewiſe the E. and W. Columns.

As in the foregoing Table the Sum of N. Column is 2.03 of the S. 53.43, of the E. Column 0.00 and of the W. Colum 127.43: And ſubtracting the N. Column from the S. the Remainder is 51.40, the Difference of Latitude Southerly.

And ſubtracting the E. Column from the W. the Remainde is 127.43 tht Departure Weſterly.

Now having the Difference of Latitude and Departure, yo may find the Courſe and Diſtance by Chapter 3. Section 3 Problem 6. of *Plane Sailing*, in page 63.

By which you will find the Courſe to be W.S.W. and th Diſtance 137 Minutes nearly, as you may ſee in the Journal fo the firſt Day thereof, in pages 274, 275, 288 and 289.

Chapter III. *The Uſe of the Table of* Meridional Part *beginning* (*in page* 308.)

THIS Table ſheweth the Meridioual Parts for every Minut of Latitude; and is thus to be underſtood.

In the firſt Column towards the Left-hand (of each Page) ar the Degrees of Latitude from 1 to 89 Degrees: In the next Columns are the Meridional Parts for every 5 Minutes of La anſwering to the Degrees in the firſt Column; which on th Left-hand Page are diſtinguſhed with | 0*m* | 5*m* | 10*m* | 15*m* 20*m* | 25*m* | and on the Right-hand Page, with | 30*m* | 35*m* 40*m* | 45*m* | 50*m* | 55*m* | at the Head of the Table.

In the laſt Column of each Page towards the Right-hand is th Difference in Meridional Parts, to every 5 Minutes of Latitude by the Help of which, and the following Table of Proportion Parts, the Meridional Parts, to every Minute of Latitude ma be adjuſted.

Propoſiti

Prop. 12. *To find the Merid. Parts to every* 5 *min. of Latitude.*

Examp. 1. *Suppoſe the Latitude of* 13d. 10m. *be given; to find the* Meridional Parts *belonging to it?*

Right againſt 13d. in the firſt Column of page 308, and under 10m. (at the Head of the Table) in the 4th Column, you will find the Meridional Parts to be 797 Minutes.

Examp. 2. *Admit you were to find the* Meridional Parts *anſwering to the Latitude* 50d. 10m.?

Right againſt 50d. in the firſt Column in page 310, and under 10m. at the Head of the Table) in the 4th Column, you will find 3490, which are the Meridional Parts required.

Chap. IV. *The Uſe of the Table of* Proportional Parts, *next following the Table of* Meridional Parts, *in Page* 314.

THE Uſe of this Table, is to find the Meridional Parts to every Minute of Latitude.

Prop. 13. *To find the* Merid. Parts *for every Minute of Latitude.*

Examp. 1. *Suppoſe it was required to find the* Meridional Parts *for the Latitude* 21d. 23m.?

Firſt, Find the Meridional Parts for the Latitude 21d. 20m. (20m. being the next even 5, leſs than 23m.) which you will find in page 308, to be 1311; and right againſt 21d. in the laſt Column (noted with the Difference at the Head of the Table) you will find 5.

Secondly, With this Difference 5, go to the Table of Proportional Parts, in Page 314, and look 5 (in the firſt Column thereof) under D, which ſtands for Difference, and becauſe 23m. is 3 more than 20, look under 3 at the Head of the Fourth Column; So then right againſt 5 in the Firſt Column, and right under 3, you will find 3, which add to 1311, and it makes 1314 minutes, the Meridional Parts for the Latitude 21d. 23m. required.

Examp. 2. *Let it be required to find the* Meridional Parts *anſwering to the Latitude* 51d. 49m.?

The next leſs than 49m. is 45m. Therefore find the Meridional Parts for 51d. 45m. which is 3641, and right againſt 51d. in the Column of Difference is 8.

Now 49m. is 4m. above 45m. Therefore in the Table of Proportional Parts right againſt 8, and under 4, you will find the Proportional Parts to be 6; which add to 3641, makes 3647 min. the Merid. Parts for the Lat. 51d. 49m. required.

And thus much may ſuffice for the Uſe of theſe Tables, and for this Diſcourſe, which I hope is plaind and eaſy to every Reader.

A TABLE *of Difference of Latitude and Departure from the Meridian.*

Diſt.	¼ Point		½ Point		¾ Point		1 Point		Diſt.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.9988	0.0491	0.9952	0.0980	0.9892	0.1467	0.9808	0.1951	1
2	1.9976	0.0981	1.9903	0.1960	1.9784	0.2935	1.9616	0.3902	2
3	2:9964	0.1472	2.9855	0.2941	2.9675	0.4402	2.9424	0.5853	3
4	3.9952	0.1963	3.9807	0.3921	3.9567	0.5861	3.9232	0.7804	4
5	4.9940	0.2454	4.9759	0.4901	4.9459	0.7337	4.9040	0.9755	5
6	5.9927	0.2944	5.9711	0.5881	5.9351	0.8804	5.8847	1.1705	6
7	6.9915	0.3435	6.9663	0.6861	6.9243	1.0271	6.8655	1.3656	7
8	7.9903	0.3926	7.9615	0.7842	7.9134	1.1738	7.8463	1.5607	8
9	8.9891	0.4416	8.9567	0.8822	8.9026	1.3206	8.8271	1.7558	9
10	9.9879	0.4907	9.9519	0.9802	9.8918	1.4673	9.8079	1.9509	10
Diſt.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Diſt.
	7 ¾ Points		7 ½ Points		7 ¼ Points		7 Points		

Diſt.	1 ¼ Point		1 ½ Point		1 ¾ Point		2 Potnts		Diſt.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.9700	0.2430	0.9569	0.2903	0.9415	0.3369	0.9239	0.3827	1
2	1.9400	0.4860	1.9139	0.5806	1.8831	0.6738	1.8478	0.7654	2
3	2.9101	0.7289	2.8708	0.8709	2.8246	1.0107	2.7716	1.1480	3
4	3:8801	0.9719	3.8278	1.1612	3.7662	1.3476	3.6955	1.5307	4
5	4.8501	1.2149	4.7847	1.4515	4.7077	1.6845	4.6194	1.9133	5
6	5.8201	1.4579	5.7416	1.7417	5.6492	2.0213	5.5433	2.2961	6
7	6.7901	1.7009	6.6986	2.0320	6.5908	2.3582	6.4672	2.6788	7
8	7.7602	1.9438	7.6555	2.3223	7.5323	2.6851	7.3910	3.0614	8
9	8.7302	2.1868	8.6125	2.6146	8.4739	3.0320	8.3149	3.4441	9
10	9.7002	2.4298	9.5694	2.9029	9.4154	3.3689	9.2388	3.8268	10
Diſt.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Diſt.
	6 ¾ Points		6 ½ Points		6 ¼ Points		6 Points		

A TABLE *of Difference of Latitude and Departure from the Meridian.*

Dift.	2 ¼ Points		2 ½ Points		2 ¾ Points		3 Points		Dift.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.9040	0.4270	0.8819	0.4741	0.8577	0.5141	0.8315	0.5556	1
2	1.8080	0.8551	1.7638	0.9428	1.7155	1.0282	1.6629	1.1111	2
3	2.7120	1.2827	2.6458	1.4142	2.5732	1,5423	2.4944	1.6667	3
4	3.6160	1.7102	3.5277	1.8856	3.4302	2.0564	3.3259	2.2223	4
5	4.5200	2.1378	4.4100	2.3570	4.2887	2.5705	4.1574	2.7779	5
6	5.4240	2.5654	5.2915	2.8284	5.1464	3.0846	4.9888	3.3334	6
7	6.3280	2.9929	6.1734	3.2998	6.0041	3.5987	5.8208	3.8883	7
8	7.2320	3.4205	7.0554	3.7712	6.8618	4.1128	6.6518	4.4446	8
9	8.1380	3.8480	7.9373	4.2426	7.7196	4.6269	7.4837	5.0001	9
10	9.0400	4.2756	8.8192	4.7140	8.5773	5.1410	8.3147	5.5557	10
Dift.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dift.
	5 ¾ Points		5 ½ Points		5 ¼ Points		5 Points		

Dift.	3 ¼ Points		3 ½ Points		3 ¾ Points		4 Points		Dift.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.8032	0.5957	0.7730	0.6344	0.7410	0.6716	0.7071	0.7071	1
2	1.6064	1.1914	1.5460	1.2688	1.4819	1.3431	1.4142	1.4142	2
3	2,4096	1.7871	2.3190	1.9032	2.2229	2.0147	2.1213	2.1213	3
4	3.2128	2.3828	3.0920	2.5356	2.9638	2.6862	2.8284	2.8284	4
5	4.0161	2.9800	3.8651	3.1720	3.7048	3.3578	3.5356	3.5356	5
6	4.8193	3.5742	4.6381	3.8064	4.4457	4.0294	4.2427	4.2427	6
7	5.6225	4.1699	5.4111	4.4408	5.1867	4.7009	4.9498	4.9498	7
8	6.4257	4.7656	6.1841	5.0852	5.9276	5.3725	5.6569	5.6569	8
9	7.2289	5.3613	6.9571	5.7096	6.6686	6.0448	6.3640	6.3640	9
10	8.0321	5,9570	7 7301	6.3440	7.4095	6.7156	7.0711	7.0711	10
Dift.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dift.
	4 ¾ Points		4 ½ Points		4 ¼ Points		4 Points		

The Deg. of Lat.	The Minutes of each Degree.						The Difference.
	0*m.*	5*m.*	10*m.*	15*m.*	20*m.*	25*m.*	
	The Meridional Parts.						
0	0	5	10	15	20	25	5
1	60	65	70	75	80	85	5
2	120	125	130	135	140	145	5
3	180	185	190	195	200	205	5
4	240	245	250	255	260	265	5
5	300	305	310	315	320	325	5
6	361	366	371	376	381	386	5
7	421	426	431	436	441	446	5
8	482	487	492	497	502	507	5
9	542	547	552	557	562	568	5
10	603	608	613	618	623	628	5
11	664	669	674	679	684	690	5
12	725	730	736	741	746	751	5
13	787	792	797	802	807	812	5
14	848	854	859	864	869	874	5
15	910	916	921	926	931	936	5
16	973	978	983	988	994	999	5
17	1035	1041	1046	1051	1056	1061	5
18	1098	1103	1109	1114	1119	1125	5
19	1161	1167	1172	1177	1183	1188	5
20	1225	1230	1236	1241	1246	1252	5
21	1289	1295	1300	1305	1311	1316	5
22	1354	1359	1364	1370	1375	1381	6
23	1419	1424	1429	1435	1440	1446	6
24	1484	1490	1495	1500	1506	1511	6
25	1550	1556	1561	1567	1572	1578	6
26	1616	1622	1628	1633	1639	1644	6
27	1684	1689	1695	1700	1706	1712	6
28	1751	1757	1762	1768	1774	1780	6
29	1819	1825	1831	1837	1842	1848	6

The Deg. of Lat.	The Minutes of each Degree.						The Difference.
	30*m.*	35*m.*	40*m.*	45*m.*	50*m.*	55*m.*	
	The Meridional Parts.						
0	30	35	40	45	50	55	5
1	90	95	100	105	110	115	5
2	150	155	160	165	170	175	5
3	210	215	220	225	230	235	5
4	270	275	280	285	290	295	5
5	330	335	341	346	351	356	5
6	391	396	401	406	411	416	5
7	451	456	461	466	471	476	5
8	512	517	522	527	532	537	5
9	573	578	583	588	593	598	5
10	634	639	644	649	654	659	5
11	695	700	705	710	715	720	5
12	756	761	766	771	776	782	5
13	818	823	828	833	838	843	5
14	880	885	890	895	900	905	5
15	942	947	952	957	962	968	5
16	1004	1009	1014	1020	1025	1030	5
17	1067	1072	1077	1082	1088	1093	5
18	1130	1135	1140	1146	1151	1156	5
19	1193	1199	1204	1209	1214	1220	5
20	1257	1262	1268	1273	1278	1284	5
21	1321	1327	1332	1338	1343	1348	5
22	1386	1392	1397	1402	1408	1413	6
23	1451	1457	1462	1468	1473	1479	6
24	1517	1522	1528	1533	1539	1544	6
25	1583	1589	1594	1600	1605	1611	6
26	1650	1656	1661	1667	1672	1678	6
27	1717	1723	1729	1734	1740	1746	6
28	1785	1791	1797	1802	1808	1814	6
29	1854	1860	1865	1871	1877	1883	6

The Deg. of Lat.	The Minutes of each Degree.						The Difference.
	0*m.*	5*m.*	10*m.*	15*m.*	20*m.*	25*m.*	
	The Meridional Parts.						
30	1888	1894	1900	1906	1912	1917	6
31	1958	1964	1970	1976	1981	1987	6
32	2028	2034	2040	2046	2052	2058	6
33	2100	2105	2111	2117	2123	2129	6
34	2171	2177	2184	2190	2196	2202	6
35	2244	2250	2257	2263	2269	2275	6
36	2318	2324	2330	2337	2343	2349	6
37	2393	2399	2405	2411	2418	2424	6
38	2468	2475	2481	2487	2494	2500	6
39	2545	2551	2558	2564	2571	2577	6
40	2623	2629	2636	2642	2649	2655	6
41	2702	2708	2715	2722	2728	2735	7
42	2782	2788	2795	2802	2809	2815	7
43	2863	2870	2877	2884	2891	2897	7
44	2946	2953	2960	2967	2974	2981	7
45	3030	3037	3044	3051	3058	3065	7
46	3116	3123	3130	3137	3144	3152	7
47	3203	3210	3217	3225	3232	3240	8
48	3292	3299	3306	3314	3322	3329	8
49	3382	3390	3397	3405	3413	3420	8
50	3474	3482	3490	3498	3506	3514	8
51	3569	3577	3585	3593	3601	3609	8
52	3665	3673	3681	3690	3698	3706	8
53	3764	3772	3780	3789	3797	3806	8
54	3865	3873	3882	3890	3899	3907	8
55	3968	3977	3985	3994	4003	4012	9
56	4074	4083	4092	4101	4110	4119	9
57	4183	4192	4201	4210	4220	4229	9
58	4294	4304	4313	4323	4332	4342	10
59	4409	4419	4429	4438	4448	4458	10

The Minutes of each Degree.						The Difference
30*m.*	35*m.*	40*m.*	45*m.*	50*m.*	55*m.*	
The Meridional Parts.						
1923	1929	1935	1941	1946	1952	6
1993	1999	2005	2011	2017	2022	6
2064	2070	2076	2082	2088	2094	6
2135	2141	2147	2153	2159	2165	6
2208	2214	2220	2226	2232	2238	6
2281	2287	2293	2299	2306	2312	6
2355	2361	2368	2374	2380	2386	6
2430	2437	2443	2449	2456	2462	6
2506	2513	2519	2526	2532	2538	6
2584	2590	2597	2603	2610	2616	6
2662	2669	2675	2682	2688	2695	6
2742	2748	2755	2762	2768	2775	7
2822	2829	2836	2843	2849	2856	7
2904	2911	2918	2925	2932	2939	7
2988	2995	3002	3009	3016	3023	7
3073	3080	3086	3094	3101	3108	7
3159	3166	3173	3181	3188	3195	7
3247	3254	3262	3269	3277	3284	8
3337	3344	3352	3359	3367	3374	8
3428	3436	3443	3451	3459	3467	8
3521	3529	3537	3545	3553	3561	8
3617	3625	3633	3641	3649	3657	8
3714	3722	3731	3739	3747	3755	8
3814	3822	3831	3839	3848	3856	8
3916	3925	3933	3942	3951	3959	8
4021	4029	4038	4047	4056	4065	9
4128	4137	4146	4155	4164	4173	9
4238	4247	4257	4266	4275	4285	9
4351	4361	4370	4380	4390	4399	10
4468	4478	4488	4497	4507	4517	10

The Deg. of Lat.	The Minutes of each Degree.						The Difference.
	0*m.*	5*m.*	10*m.*	15*m.*	20*m.*	25*m.*	
	The Meridional Parts.						
60	4527	4537	4547	4557	4568	4578	10
61	4649	4660	4670	4680	4691	4701	10
62	4775	4786	4796	4807	4818	4829	11
63	4905	4916	4927	4938	4949	4960	11
64	5039	5051	5062	5074	5085	5097	12
65	5179	5191	5203	5214	5226	5238	12
66	5324	5336	5348	5361	5373	5385	12
67	5474	5487	5500	5513	5526	5539	13
68	5631	5644	5658	5671	5685	5698	13
69	5795	5809	5823	5837	5851	5865	14
70	5966	5981	5995	6010	6025	6040	15
71	6146	6161	6177	6192	6208	6223	15
72	6335	6351	6367	6384	6400	6417	16
73	6534	6552	6569	658[illegible]	6603	6621	17
74	6746	6764	6782	6801	6819	6838	18
75	6970	6990	7009	7029	7048	7068	20
76	7210	7231	7252	7273	7294	7315	21
77	7467	7490	7512	7535	7557	7580	23
78	7745	7769	7793	7817	7842	7867	25
79	8046	8072	8099	8125	8152	8179	27
80	8375	8404	8433	8463	8492	8522	30
81	8739	8771	8803	8836	8869	8903	33
82	9145	9182	9218	9255	9292	9330	37
83	9606	9647	9689	9731	9774	9817	43
84	10137	10185	10234	10283	10334	10385	51
85	10765	10822	10881	10941	11002	11064	62
86	11533	11605	11679	11755	11832	11911	77
87	12522	12619	12719	12821	12927	13036	109
88	13916	14063	14216	14376	14543	14720	
89	16300	16599	16926	17289	17693	18153	

The Deg. of Lat.	The Minutes of each Degree.						The Difference
	30*m.*	35*m.*	40*m.*	45*m.*	50*m.*	55*m.*	
	The Meridional Parts.						
60	4588	4598	4608	4618	4629	4639	10
61	4712	4722	4733	4743	4754	4764	10
62	4839	4850	4861	4872	4883	4894	11
63	4972	4983	4994	5005	5017	5028	11
64	5108	5120	5132	5143	5155	5167	12
65	5250	5263	5275	5287	5299	5311	12
66	5398	5411	5423	5436	5449	5461	13
67	5552	5565	5578	5591	5604	5617	13
68	5712	5725	5739	5753	5767	5781	14
69	5879	5894	5908	5922	5937	5951	14
70	6055	6070	6085	6100	6115	6130	15
71	6239	6255	6271	6287	6303	6319	16
72	6433	6450	6467	6483	6500	6517	17
73	6639	6656	6674	6692	6710	6728	18
74	6856	6875	6894	6913	6932	6951	19
75	7088	7108	7128	7149	7169	7189	20
76	7336	7358	7379	7401	7423	7445	22
77	7603	7626	7650	7673	7697	7721	24
78	7892	7917	7942	7968	7994	8020	26
79	8207	8234	8262	8290	8318	8347	28
80	8552	8583	8614	8644	8676	8707	31
81	8936	8970	9005	9039	9074	9110	36
82	9368	9407	9445	9485	9525	9565	40
83	9861	9906	9951	9996	10043	10089	46
84	10437	10489	10542	10597	10652	10707	55
85	11127	11192	11257	11324	11392	11462	68
86	11992	12075	12160	12247	12336	12428	89
87	13149	13266	13386	13511	13641	13776	
88	14906	15102	15311	15532	15770	16024	
89	18683	19209	20076	21065	22459	24842	

D.	1	2	3	4
5	1	2	3	4
6	1	2	3	5
7	1	3	4	6
8	2	3	5	6
9	2	4	5	7
10	2	4	6	8
11	2	4	7	9
12	2	5	7	10
13	3	5	8	10
14	3	6	8	11
15	3	6	9	12
16	3	6	10	13
17	3	7	10	14
18	4	7	11	14
19	4	8	11	15
20	4	8	12	16
21	4	8	13	17
22	4	9	13	18
23	5	9	14	18
24	5	10	14	19

D.	1	2	3	4
25	5	10	15	20
26	5	10	16	21
27	5	11	16	22
28	6	11	17	22
30	6	12	18	24
31	6	12	19	25
33	7	13	20	26
35	7	14	21	28
37	7	15	22	30
40	8	16	24	32
42	8	17	25	34
46	9	18	28	37
50	10	20	30	40
55	11	22	33	44
61	12	24	37	49
68	14	27	41	54
76	15	30	46	61
88	18	35	53	70
105	21	63	53	84
115	23	69	69	92

A Table of LOGARITHMS

For Numbers increaſing in their Natural Order, from an Unit to 10,000.
With a Table of Artificial SINES, TANGENTS, and SECANTS, the RADIUS 10,000000; and to every Degree and Minute of the *Quadrant.*

N.	Logar.	N.	Logar.	N.	Logar.
1	0.000000	34	1.531479	67	1.826075
2	0.301030	35	1.544068	68	1.832509
3	0.477121	36	1.556302	69	1.838849
4	0.602060	37	1.568202	70	1.845098
5	0.698970	38	1.579784	71	1.851258
6	0.778151	39	1 591065	72	1 857332
7	0.845098	40	1.602060	73	1.863323
8	0.903090	41	1.612784	74	1.869232
9	0.954242	42	1.623249	75	1.875061
10	1.000000	43	1.633468	76	1.880814
11	1.041393	44	1.643453	77	1.886491
12	1.079181	45	1.653212	78	1 892095
13	1.113943	46	1.662758	79	1.897627
14	1.146128	47	1.672098	80	1.903090
15	1.176091	48	1.681241	81	1.908485
16	1.204120	49	1.690196	82	1.913814
17	1.230449	50	1 698970	83	1.919078
18	1.255272	51	1.707570	84	1.924279
19	1.278754	52	1.716003	85	1.929419
20	1.301030	53	1.724276	86	1.934498
21	1.322219	54	1.732394	87	1.939519
22	1.342423	55	1.740363	88	1.944483
23	1.361728	56	1.748188	89	1.949390
24	1.380211	57	1.755875	90	1.954242
25	1.397940	58	1.763428	91	1,959041
26	1.414973	59	1.770852	92	1.963788
27	1.431364	60	1.778151	93	1.968483
28	1,447158	61	1.785330	94	1.973128
29	1.462398	62	1.792392	95	1.977724
30	1.477121	63	1.799340	96	1.982271
31	1.491362	64	1.806180	97	1.986772
32	1.505150	65	1.812913	98	1.991226
33	1.518514	66	1.819544	99	1.995635

Num	0	1	2	3	4	Diff
100	2 000000	2,000434	2.000868	2.001301	2.001734	43
101	2.004321	2.004751	2.005180	2 005609	2.006038	42
102	2.008600	2.009026	2.009451	2.009876	2 010300	42
103	2.012837	2.013256	2.013680	2.014100	2.014520	41
104	2.017033	2.017451	2.017868	2.018284	2.018700	41
105	2.021189	2.021603	2.022016	2.022428	2.022841	41
106	2 025306	2 025715	2.026124	2.026533	2.026942	40
107	2.029384	2.029789	2.030195	2.030600	2.031004	40
108	2.033424	2.033826	2.034227	2.034628	2.035029	40
109	2 037426	2.037825	2.038223	2.038620	2.039017	39
110	2.041393	2.041787	2.042182	2.042575	2.042969	39
111	2.045323	2.045714	2.046105	2.046495	2.046885	38
112	2.049218	2.049606	2 049993	2.050380	2.050766	38
113	2.053078	2.053463	2.053846	2.054230	2.054613	38
114	2.056905	2.057286	2.057666	2.058046	2.058426	37
115	2.060698	2.061075	2.061452	2.061829	2.062206	37
116	2.064458	2.064832	2.065206	2 065580	2.065953	37
117	2.068186	2.068557	2.068928	2.069298	2.069668	36
118	2.071882	2.072250	2.072617	2.072985	2.073352	36
119	2.075547	2.075912	2.076276	2 076640	2.077004	36
120	2.079181	2.079543	2.079904	2.080266	2.080626	36
121	2.082785	2.083144	2 083503	2.083861	2.084219	35
122	2.086360	2 086716	2.087071	2.087426	2.087781	35
123	2.089905	2.090258	2.090611	2.090963	2.091315	35
124	2.093422	2.093772	2.094[illegible]22	2.094471	2.094820	34
125	2.096910	2.097257	2.097604	2.097951	2.098297	34
126	2 100370	2.100715	2.101059	2.101403	2.101747	34
127	2.103804	2.104145	2.104487	2.104828	2.105169	34
128	2.107210	2.107549	2.107888	2.108227	2.108565	33
129	2.110590	2.110926	2.111262	2.111598	2.111934	33
130	2.113943	2.114277	2.114611	2.114944	2.115278	33
131	2.117271	2.117603	2.117934	2.118265	2.118595	33
132	2.120574	2.120903	2.121231	2.121560	2.121888	32
133	2.123852	2.124178	2.124504	2.124830	2.125156	32
134	2.127105	2.127429	2.127752	2.128076	2.128399	32
135	2.130334	2.130655	2.130977	2.131298	2.131619	32
136	2.133539	2.133858	2.134177	2.134496	2.134814	31
137	2.136721	2.137037	2.137354	2.137670	2.137987	31
138	2.139879	2.140194	2.140508	2.140822	2.141136	3
139	2.143015	2.143327	2.143639	2.143951	2.144263	3
140	2.146128	2.146438	2.146748	2.147058	2.[illegible]7367	3
141	2,149219	2.149527	2.149835	2.150142	2.150449	3
142	2.152288	2.152594	2.152900	2.153205	2.153510	3

um	5	6	7	8	9	Diff.
100	2.002166	2.002598	2.003029	2.003467	2.003891	432
101	2.006466	2.006894	2.007321	2.007748	2.008174	428
102	2.010724	2.011147	2.011570	2.011993	2.012415	424
103	2.014940	2.015360	2.015779	2.016198	2.016615	419
104	2.019116	2.019532	2,019947	2.020361	2.020775	416
105	2.023252	2.023664	2.024075	2.024486	2.024896	412
106	2,027350	2.027757	2.028164	2.028571	2.028978	408
107	2.031408	2.031812	2.032216	2.032619	2.033021	404
108	2.035430	2.035830	2.036229	2.036629	2.037028	400
109	2.039414	2.039811	2.040207	2.040602	2.040998	396
110	2.043362	2.043755	2.044148	2.044540	2.044931	393
111	2.047275	2.047664	2.048053	2.048442	2.048830	389
112	2.051152	2.051538	2,051924	2,052309	2.052694	386
113	2.054996	2.055378	2.055760	2,056142	2.056524	382
114	2.058805	2.059185	2,059563	2.059942	2.060320	378
115	2.062582	2.062958	2.063333	2.063709	2.064083	376
116	2.066326	2.066699	2.067071	2.067443	2.067814	372
117	2.070038	2.070407	2.070776	2.071145	2.071514	369
118	2.073718	2.074085	2.074451	2.074816	2.075182	366
119	2.077368	2.077731	2.078094	2.078457	2.078819	363
120	2.080987	2.081347	2.081707	2.082067	2.082426	360
121	2.084576	2.084934	2.085291	2.085647	2.086004	357
122	2.088136	2.088490	2.088845	2.089198	2.089552	354
123	2.091667	2.092018	2.092370	2.092721	2.093071	351
124	2.095169	2.095518	2.095866	2.096215	2.096562	349
125	2.098644	2.098990	2.099335	2.099681	2.100026	346
126	2.102090	2.102434	2.102777	2.103119	2.103462	343
127.	2.105510	2.105851	2.106191	2.106531	2.106870	340
128	2.108903	2.109241	2.109578	2.109916	2.110253	338
129	2.112270	2.112605	2.112940	2.113275	2.113609	335
130	2.115610	2.115943	2.116276	2.116608	2.116940	333
131	2.118926	2.119256	2.119586	2,119915	2.120245	330
132	2.122216	2.122543	2.122871	2.123198	2.12352[illegible]	328
133	2.125481	2.125806	2.126131	2.126456	2.1267[illegible]1	325
134	2.128722	2.129045	2.129368	2.129690	2.1300[illegible]2	323
135	2.131939	2.132260	2.132580	2.132900	2.133219	320
136	2,135133	2.135451	2.135768	2.136086	2.136403	318
137	2.138303	2.138618	2.138934	2.139249	2.139564	315
138	2.141450	2.141763	2.142076	2.142389	2.142702	314
139	2.144574	2.144885	2.145196	2.145507	2.145818	311
140	2.147676	2.147985	2.148294	2.148603	2.148911	309
141	2.150756	2,151063	2.151370	2.151676	2.151982	307
142	2.153815	2.154119	2.154424	2.154728	2.155032	303

Num	0	1	2	3	4	Di
143	2.155336	2.155640	2.155943	2.156246	2.156549	3
144	2.158362	2.158664	2.158965	2.159266	2.159567	3
145	2,161368	2.161667	2.161967	2.162266	2.162564	2
146	2.164353	2.164650	2.164947	2.165244	2.165541	2
147	2.167317	2.167613	2.167908	2.168203	2.168497	2
148	2,170262	2.170555	2.170848	2.171141	2.171434	2
149	2.173186	2.173478	2.173768	2.174060	2.174351	2
150	2.176091	2.176381	2.176670	2.176959	2.177248	2
151	2.178977	2.179264	2.179552	2.179839	2.180126	2
152	2.181844	2.182129	2.182415	2.182700	2.182985	2
153	2.184691	2.184975	2.185259	2.185542	2.185825	2
154	2.187521	2.187803	2.188084	2.188366	2.188647	2
155	2.190332	2,190612	2.190892	2.191171	2.191451	2
156	2.193125	2,193403	2.193681	2.193959	2.194237	2
157	2.195900	2.196176	2.196452	2.196729	2.197005	2
158	2.198657	2.198932	2.199206	2.199481	2.199755	2
159	2.201397	2,201670	2.201943	2.202216	2.202488	2
160	2.204120	2.204391	2.204662	2,204933	2,205204	2
161	2.206826	2.207095	2.207365	2.207634	2.207903	2
162	2.209515	2.209783	2.210051	2.210318	2.210586	2
163	2.212188	2.212454	2.212720	2 212986	2.213252	2
164	2,214844	2.215109	2.215373	2:215638	2.215902	2
165	2.217484	2.217747	2.218010	2,218273	2.218535	2
166	2.220108	2.220370	2.220631	2.220892	2.221153	2
167	2.222716	2.222976	2.223236	2,223496	2.223755	2
168	2.225309	2.225568	2.325826	2,226084	2.226342	2
179	2.227887	2.228144	2.228400	2.228657	2.228913	2
170	2.230449	2.230704	2.230960	2,231215	2.231470	2
171	2.2329[illegible]	2.233250	2.233504	2.233757	2.234011	2
172	2.2355[illegible]	2.235781	2.236033	2.236285	2.236537	2
173	2.238046	2.238297	2.238548	2.238799	2.239049	2
174	2.240549	2.240799	2.241048	2,241297	2.241546	2
175	2.243038	2.243286	2.243534	2.243782	2,244030	2
176	2.245513	2.245759	2.246006	2.246252	2.246499	2
177	2.247973	2.248219	2 248464	2.248709	2.248954	2
178	2.250420	2.250664	2.250908	2.251151	2.251395	2
179	2.252853	2.253096	2.253338	2.253580	2,253822	2
180	2.255272	2.255514	2.255755	2.255996	2,256237	2
181	2.257679	2.257918	2.258158	2.258398	2,258637	2
182	2.260071	2.260310	2.260548	2.260787	2,261025	2
183	2.262451	2.262688	2,262925	2.263162	2.263399	2
184	2.264813	2.265054	2.265290	2.265525	2.265761	2
185	2.267172	2.267406	2.267641	2.267875	2.268110	2

um	5	6	7	8	9	Diff.
43	2.156852	2.157154	2.157457	2.157759	2.158061	302
44	2.159868	2.160168	2.160468	2.160769	2.161068	301
45	2.162863	2.163161	2.163460	2.163757	2.164055	299
46	2.165838	2.166134	2.166430	2.166726	2.167022	297
47	2.168792	2.169086	2.169380	2.169674	2.169968	295
48	2.171726	2.172019	2.172311	2.172603	2.172895	292
49	2.174641	2.174932	2.175222	2.175512	2.175802	291
50	2.177536	2.177825	2.178113	2.178401	2.178689	289
51	2.180413	2.180699	2.180986	2.181272	2.181558	287
52	2.183270	2.183554	2.183839	2.184123	2.184407	285
53	2.186108	2.186391	2.186674	2.186956	2.187239	283
54	2.188928	2.189209	2.189490	2.189771	2.190051	281
55	2.191730	2.192010	2.192289	2.192567	2.192846	279
56	2.194514	2.194792	2.195069	2.195346	2.195623	278
57	2.197281	2.197556	2.197832	2.198107	2.198382	276
58	2.200029	2.200303	2.200577	2.200850	2.201124	274
59	2.202761	2.203033	2.203305	2.203577	2.203848	272
60	2.205475	2.205745	2.206016	2.206286	2.206556	271
61	2.208172	2.208441	2.208710	2.208978	2.209247	269
62	2.210853	2.211120	2.211388	2.211654	2.211921	267
63	2.213518	2.213783	2.214049	2.214314	2.214579	266
64	2.216166	2.216430	2.216694	2.216957	2.217221	264
65	2.218798	2.219060	2.219322	2.219584	2.219846	262
66	2.221414	2.221675	2.221936	2.222196	2.222456	261
67	2.224015	2.224274	2.224533	2.224792	2.225051	259
68	2.226600	2.226858	2.227115	2.227372	2.227630	258
69	2.229170	2.229426	2.229682	2.229938	2.230193	256
70	2.231724	2.231979	2.232233	2.232488	2.232742	254
71	2.234264	2.234517	2.234770	2.235023	2.235276	253
72	2.236789	2.237041	2.237292	2.237544	2.237795	251
73	2.239299	2.239550	2.239800	2.240050	2.240300	250
74	2.241795	2.242044	2.242293	2.242541	2.242790	249
75	2.244277	2.244524	2.244772	2.245019	2.245266	248
76	2.246745	2.246991	2.247236	2.247482	2.247728	246
77	2.249198	2.249443	2.249687	2.249932	2 250176	245
78	2.251638	2.251881	2.252125	2.252367	2 252610	243
79	2.254064	2.254306	2.254548	2.254790	2.255031	242
80	2.256477	2.256718	2.256958	2.257198	2.257439	241
81	2.258877	2.259116	2.259355	2.259594	2.259833	239
82	2.261263	2.261501	2.261738	2.261976	2.262214	238
83	2.263636	2.263873	2.264109	2.264345	2.264582	237
84	2.265996	2.266232	2.266467	2.266702	2.266937	235
85	2.268344	2.268578	2.268812	2.269046	2.269279	234

Num	0	1	2	3	4	Diff
186	2.269513	2.269746	2.269980	2.270213	2.270446	23
187	2.271842	2.272074	2.272306	2.272538	2.272770	23
188	2.274158	2.274389	2.274620	2.274850	2.275081	23
189	2.276462	2.276691	2.276921	2.277151	2.277380	22
190	2.278754	2.278982	2.279210	2.279439	2.279667	22
191	2.281033	2.281261	2.281488	2.281715	2.281942	22
192	2.283301	2.283527	2.283753	2.283979	2.284205	22
193	2.285557	2.285782	2 286007	2.286232	2.286456	22
194	2.287802	2,288025	2.288249	2.288473	2.288696	22
195	2.290035	2.290257	2.290480	2.290702	2.290925	22
196	2.292256	2.292478	2.292699	2.292920	2.293141	22
197	2 294466	2.294687	2.294907	2.295127	2.295347	22
198	2.296665	2.296884	2.297104	2.297323	2.297542	21
199	2.298853	2.299071	2.299289	2.299507	2.299725	21
200	2.301030	2.301247	2.301464	2.301681	2.301898	21
201	2.303196	2.303412	2.303628	2.303844	2.304059	21
202	2.305351	2.305566	2 305781	2.305996	2.306210	21
203	2.307496	2.307710	2.307924	2.308137	2.308351	21
204	2.309630	2.309843	2.310056	2.310268	2.310481	21
205	2.311754	2.311966	2.312177	2.312389	2.312600	21
206	2.313867	2.314078	2.314289	2.314499	2.314710	21
207	2.315970	2.316180	2.316390	2.316599	2.316809	20
208	2.318063	2.318272	2.318481	2.318689	2.318898	20
209	2.320146	2.320354	2.320562	2.320769	2.320977	20
210	2.322219	2.322426	2.322633	2.322839	2.323046	20
211	2.324282	2.324488	2.324694	2.324899	2.325105	20
212	2.326336	2.326541	2.326745	2.326950	2.327154	20
213	2.328380	2.328583	2.328787	2.328991	2.329194	20
214	2.330414	2.330617	2.330819	2.331022	2.331225	20
215	2.332438	2.332640	2.332842	2.333044	2.333246	20
216	2.334454	2.334655	2.334856	2.335056	2.335257	20
217	2.336460	2.336660	2.336860	2.337060	2.337260	20
218	2.338456	2.338656	2.338855	2.339054	2.339253	19
219	2.340444	2.340642	2.340840	2.341039	2.341237	19
220	2.342423	2.342620	2.342817	2.343014	2.343212	19
221	2.344392	2.344589	2.344785	2.344981	2.345178	19
222	2.346353	2.346549	2.346744	2.346939	2.347135	19
223	2.348305	2.348500	2.348694	2.348889	2.349083	19
224	2.350248	2.350442	2.350636	2.350829	2.351023	19
225	2.352182	2.352375	2.352568	2.352761	2.352954	19
226	2.354108	2.354301	2.354493	2.354684	2.354876	19
227	2.356026	2.356217	2.356408	2.356599	2.356790	19
228	2.357935	2.358125	2.358316	2.358506	2.358696	19

Num	5	6	7	8	9	Diff.
186	2.270679	2.270912	2.271144	2.271377	2.271609	233
187	2.273001	2.273233	2.273464	2.273696	2.273927	232
188	2.275311	2.275542	2.275772	2.276002	2.276232	230
189	2.277609	2.277838	2.278067	2.278296	2.278525	229
190	2.279895	2.280123	2.280351	2.280578	2.280806	228
191	2.282169	2.282395	2.282622	2.282849	2.283075	227
192	2.284431	2.284656	2.284882	2.285107	2.285332	226
193	2.286681	2.286905	2.287130	2.287354	2.287579	225
194	2.288920	2.289143	2.289366	2.289589	2.289812	223
195	2.291147	2.291369	2.291591	2.291813	2.292034	222
196	2.293362	2.293583	2.293804	2.294025	2.294246	221
197	2.295567	2.295787	2.296007	2.296226	2.296446	220
198	2.297760	2.297979	2.298198	2.298416	2.298635	219
199	2.299943	2.300160	2.300378	2.300595	2.300813	218
200	2.302114	2.302331	2.302547	2.302764	2.302980	217
201	2.304275	2.304490	2.304706	2.304921	2.305136	216
202	2.306425	2.306639	2.306854	2.307068	2.307282	215
203	2.308564	2.308778	2.308991	2.309204	2.309417	213
204	2.310693	2.310906	2.311118	2.311330	2.311542	212
205	2.312812	2.313023	2.313234	2.313445	2.313656	211
206	2.314920	2.315130	2.315340	2.315550	2.315760	210
207	2.317018	2.317227	2.317436	2.317645	2.317854	209
208	2.319106	2.319314	2.319522	2.319730	2.319938	208
209	2.321184	2.321391	2.321598	2.321805	2.322012	207
210	2.323252	2.323458	2.323664	2.323871	2.324077	206
211	2.325310	2.325516	2.325721	2.325926	2.326131	205
12	2.327359	2.327563	2.327767	2.327972	2.328176	204
213	2.329398	2.329601	2.329804	2.330008	2.330211	203
214	2.331427	2.331630	2.331832	2.332034	2.332236	202
15	2.333447	2.333649	2.333850	2.334051	2.334253	202
16	2.335458	2.335658	2.335859	2.336059	2.336259	201
17	2.337459	2.337659	2.337858	2.338058	2.338257	200
18	2.339451	2.339650	2.339849	2.340047	2.340246	199
19	2.341434	2.341632	2.341830	2.342028	2.342225	198
20	2.343409	2.343605	2.343802	2.343999	2.344196	197
21	2.345374	2.345570	2.345766	2.345961	2.346157	196
22	2.347330	2.347525	2.347720	2.347915	2.348110	195
23	2.349277	2.349472	2.349666	2.349860	2.350054	194
24	2.351216	2.351410	2.351603	2.351796	2.351989	193
25	2.353146	2.353339	2.353532	2.353724	2.353916	193
26	2.355068	2.355260	2.355451	2.355643	2.355834	192
27	2.356981	2.357172	2.357363	2.357554	2.357744	191
228	2.358886	2.359076	2.359266	2.359456	2.359646	190

Num	0	1	2	3	4	Diff
229	2.359835	2.360025	2.360215	2.360404	2.360593	18
230	2.361728	2.361917	2.362105	2.362294	2.362482	18
231	2.363612	2.363800	2.363988	2.364176	2.364363	18
232	2.365488	2.365675	2.365862	2.366049	2.366236	18
233	2.367356	2.367542	2.367728	2.367915	2.368101	18
234	2.369216	2.369401	2.369587	2.369772	2.369958	18
235	2.371068	2.371253	2.371437	2.371622	2.371806	18
236	2.372912	2.373096	2.373280	2.373464	2.373647	18
237	2.374748	2.374932	2.375115	2.375298	2.375481	18
238	2.376577	2.376759	2.376942	2.377124	2.377306	18
239	2.378398	2.378580	2.378761	2.378943	2.379124	18
240	2.380211	2.380392	2.380573	2.380754	2.380934	18
241	2.382017	2.382197	2.382377	2.382557	2.382737	18
242	2.383815	2.383995	2.384174	2.384353	2.384533	17
243	2.385606	2.385785	2.385964	2.386142	2.386321	17
244	2.387390	2.387568	2.387746	2.387923	2.388101	17
245	2.389166	2.389343	2.389520	2.389697	2.389874	17
246	2.390935	2.391111	2.391288	2.391464	2.391641	17
247	2.392697	2.392873	2.393048	2.393224	2.393400	17
248	2.394452	2.394627	2.394802	2.394977	2.395152	17
249	2.396199	2.396374	2.396548	2.396722	2.396896	17
250	2.397940	2.398114	2.398287	2.398461	2.398634	17
251	2.399674	2.399847	2.400020	2.400192	2.400365	17
252	2.401400	2.401573	2.401745	2.401917	2.402089	17
253	2.403120	2.403292	2.403464	2.403635	2.403807	17
254	2.404834	2.405005	2.405175	2.405346	2.405517	17
255	2.406540	2.406710	2.406881	2.407051	2.407221	17
256	2.408240	2.408409	2.408579	2.408749	2.408918	16
257	2.409933	2.410102	2.410271	2.410440	2.410608	16
258	2.411620	2.411788	2.411956	2.412124	2.412292	16
259	2.413300	2.413467	2.413635	2.413802	2.413970	16
260	2.414973	2.415140	2.415307	2.415474	2.415641	16
261	2.416640	2.416807	2.416973	2.417139	2.417306	16
262	2.418301	2.418467	2.418633	2.418798	2.418964	16
263	2.419956	2.420121	2.420286	2.420451	2.420616	16
264	2.421604	2.421768	2.421933	2.422097	2.422261	16
265	2.423246	2.423410	2.423573	2.423737	2.423901	16
266	2.424882	2.425045	2.425208	2.425371	2.425534	16
267	2.426511	2.426674	2.426836	2.426999	2.427161	16
268	2.428135	2.428297	2.428459	2.428621	2.428782	16
269	2.429752	2.429914	2.430075	2.430236	2.430398	16
270	2.431364	2.431525	2.431685	2.431846	2.432007	16
271	2.432969	2.433129	2.433290	2.433450	2.433610	16

um	5	6	7	8	9	Diff.
229	2.360783	2.360972	2.361161	2.361350	2.361539	189
230	2.362671	2.362859	2.363048	2.363236	2.363424	188
231	2.364551	2.364739	2.364926	2.365113	2.365301	188
232	2.366423	2.366610	2.366796	2.366983	2.367169	187
233	2.368287	2.368473	2.368659	2.368844	2.369030	186
34	2.370143	2.370328	2.370513	2.370698	2.370883	185
35	2.371991	2.372175	2.372360	2.372544	2.372728	184
36	2.373831	2.374015	2.374198	2.374382	2.374565	184
37	2.375664	2.375846	2.376029	2.376212	2.376394	183
38	2.377488	2.377670	2.377852	2.378034	2.378216	182
39	2.379305	2.379487	2.379668	2.379849	2.380030	181
40	2.381115	2.381296	2.381476	2.381656	2.381837	181
41	2.382917	2.383097	2.383277	2.383456	2.383636	180
42	2.384712	2.384891	2.385070	2.385249	2.385427	179
43	2.386499	2.386677	2.386855	2.387034	2.387212	178
44	2.388279	2.388456	2.388634	2.388811	2.388989	178
45	2.390051	2.390228	2.390405	2.390582	2.390758	177
46	2.391817	2.391993	2.392169	2.392345	2.392521	176
47	2.393575	2.393751	2.393926	2.394101	2.394276	176
48	2.395326	2.395501	2.395676	2.395850	2.396025	175
49	2.397070	2.397245	2.397418	2.397592	2.397766	174
50	2.398808	2.398981	2.399154	2.399327	2.399501	173
51	2.400538	2.400711	2.400883	2.401056	2.401228	173
52	2.402261	2.402433	2.402605	2.402777	2.402949	172
53	2.403978	2.404149	2.404320	2.404492	2.404663	171
54	2.405688	2.405858	2.406029	2.406199	2 406370	171
55	2.407391	2.407561	2.407731	2.407900	2.408070	170
56	2.409087	2.409257	2.409426	2.409595	2.409764	169
57	2.410777	2.410946	2.411114	2.411283	2.411451	169
58	2.412460	2.412628	2.412796	2.412964	2.413132	168
59	2.414137	2.414305	2.414472	2.414639	2.414806	167
60	2.415808	2.415974	2.416141	2.416308	2.416474	167
61	2.417472	2.417638	2.417804	2.417970	2.418135	166
62	2.419129	2.419295	2.419460	2.419625	2.419791	165
63	2.420781	2.420945	2.421110	2.421275	2.421439	165
64	2.422426	2.422590	2.422754	2.422918	2.423082	164
65	2.424064	2.424228	2.424392	2.424555	2.424718	163
66	2.425697	2.425860	2.426023	2.426186	2.426349	163
67	2.427324	2.427486	2.427648	2.427811	2.427973	162
68	2.428944	2.429106	2.429268	2.429429	2.429591	162
9	2.430559	2.430720	2.430881	2.431042	2.431203	161
0	2.432167	2.432328	2.432488	2.432649	2.432809	160
1	2.433770	2.433930	2.434090	2.434249	2.434409	160

Num	0	1	2	3	4	Diff.
272	2.434569	2.434728	2.434888	2.435048	2.435207	159
273	2.436163	2.436322	2.436481	2.436640	2.436798	159
274	2.437751	2.437909	2.438067	2.438226	2.438384	158
275	2.439333	2.439491	2.439648	2.439806	2.439964	158
276	2.440909	2.441066	2.441224	2.441381	2.441538	157
277	2.442480	2.442636	2.442793	2.442950	2.443106	157
278	2.444045	2.444201	2.444357	2.444513	2.444669	156
279	2.445604	2.445760	2.445915	2.446071	2.446226	155
280	2.447158	2.447313	2.447468	2.447623	2.447778	155
281	2.448706	2.448861	2.449015	2.449170	2.449324	154
282	2.450249	2.450403	2.450557	2.450711	2.450865	154
283	2.451786	2.451940	2.452093	2.452247	2.452400	153
284	2.453318	2.453471	2.453624	2.453777	2.453930	153
285	2.454845	2.454997	2.455149	2.455302	2.455454	152
286	2.456366	2.456518	2.456670	2.456821	2.456973	152
287	2.457882	2.458033	2.458184	2.458336	2.458487	15
288	2.459392	2.459543	2.459694	2.459845	2.459995	15
289	2.460898	2.461048	2.461198	2.461348	2.461498	150
290	2.462398	2.462548	2.462697	2.462847	2.462997	150
291	2.463893	2.464042	2.464191	2.464340	2.464489	149
292	2.465383	2.465532	2.465680	2.465829	2.465977	149
293	2.466868	2.467016	2.467164	2.467312	2.467460	148
294	2.468347	2.468495	2.468643	2.468790	2.468938	147
295	2.469822	2.469969	2.470116	2.470263	2.470410	147
296	2.471292	2.471438	2.471585	2.471732	2.471878	146
297	2.472756	2.472903	2.473049	2.473195	2.473341	146
298	2.474216	2.474362	2.474508	2.474653	2.474799	14
299	2.475671	2.475816	2.475962	2.476107	2.476252	14
300	2.477121	2.477266	2.477411	2.477555	2.477700	14
301	2.478566	2.478711	2.478855	2.478999	2.479143	14
302	2.480007	2.480151	2.480294	2.480438	2.480582	14
303	2.481443	2.481586	2.481729	2.481872	2.482016	14
304	2.482874	2.483016	2.483159	2.483302	2.483445	14
305	2.484300	2.484442	2.484584	2.484727	2.484869	14
306	2.485721	2.485863	2.486005	2.486147	2.486289	14
307	2.487138	2.487280	2.487421	2.487563	2.487704	14
308	2.488551	2.488692	2.488833	2.488973	2.489114	14
309	2.489958	2.490099	2.490239	2.490380	2.490520	14
310	2.491362	2.491502	2.491642	2.491782	2.491922	14
311	2.492760	2.492900	2.493040	2.493179	2.493319	13
312	2.494155	2.494294	2.494433	2.494572	2.494711	13
313	2.495544	2.495683	2.495822	2.495960	2.496099	13
314	2.496930	2.497068	2.497206	2.497344	2.497482	13

Num	5	6	7	8	9	Diff.
272	2.435366	2.435526	2.435685	2.435844	2.436003	159
273	2.436957	2.437116	2.437275	2.437433	2.437592	159
274	2.438542	2.438700	2.438859	2.439017	2.439175	158
275	2.440122	2.440279	2.440437	2.440591	2.440752	158
276	2.441695	2.441852	2.442009	2.442166	2.442323	157
277	2.443263	2.443419	2.443576	2.443732	2.443888	157
278	2.444825	2.444981	2.445137	2.445293	2.445448	156
279	2.446382	2.446537	2.446692	2.446848	2.447003	155
280	2.447933	2.448088	2.448242	2.448397	2.448552	155
281	2.449478	2.449633	2.449787	2.449941	2.450095	154
282	2.451018	2.451172	2.451326	2.451479	2.451633	154
283	2.452553	2.452706	2.452859	2.453012	2.453165	153
284	2.454082	2.454235	2.454387	2.454540	2.454692	153
285	2.455606	2.455758	2.455910	2.456062	2.456214	152
286	2.457125	2.457276	2.457428	2.457579	2.457730	152
287	2.458638	2.458789	2.458940	2.459091	2.459242	151
288	2.460146	2.460296	2.460447	2.460597	2.460747	151
289	2.461649	2.461799	2.461948	2.462098	2.462248	150
290	2.463146	2.463296	2.463445	2.463594	2.463744	150
291	2.464639	2.464787	2.464936	2.465085	2.465234	149
292	2.466126	2.466274	2.466423	2.466571	2.466719	149
293	2.467608	2.467756	2.467904	2.468052	2.468200	148
294	2.469085	2.469233	2.469380	2.469527	2.469675	147
295	2.470557	2.470704	2.470851	2.470998	2.471145	147
296	2.472025	2.472171	2.472317	2.472464	2.472610	146
297	2.473487	2.473633	2.473779	2.473925	2.474070	146
298	2.474944	2.475090	2.475235	2.475381	2.475526	146
299	2.476397	2.476542	2.476687	2.476832	2.476976	145
300	2.477844	2.477989	2.478133	2.478278	2.478422	145
301	2.479287	2.479431	2.479575	2.479719	2.479863	144
302	2.480725	2.480869	2.481012	2.481156	2.481299	144
303	2.482159	2.482302	2.482445	2.482588	2.482731	143
304	2.483587	2.483730	2.483872	2.484015	2.484157	143
305	2.485011	2.485153	2.485295	2.485437	2.485579	142
306	2.486430	2.486572	2.486714	2.486855	2.486997	142
307	2.487845	2.487986	2.488127	2.488269	2.488410	141
308	2.489255	2.489396	2.489537	2.489677	2.489818	141
309	2.490661	2.490801	2.490941	2.491081	2.491222	140
310	2.492062	2.492201	2.492341	2.492481	2.492621	140
311	2.493458	2.493597	2.493737	2.493876	2.494015	139
312	2.494850	2.494989	2.495128	2.495267	2.495406	139
313	2.496237	2.496376	2.496514	2.496653	2.496791	139
314	2.497621	2.497759	2.497897	2.498035	2.498173	138

Num	0	1	2	3	4	Diff.
315	2.498311	2.498448	2.498586	2.498724	2.498862	138
316	2.499687	2.499824	2.499962	2.500100	2.500236	137
317	2.501059	2.501196	2.501333	2.501470	2.501607	137
318	2.502427	2.502564	2.502700	2.502837	2.502973	136
319	2.503791	2.503927	2.504063	2.504199	2.504335	13
320	2.505150	2.505286	2.505421	2.505557	2.505693	136
321	2.506505	2.506640	2.506775	2.506911	2.507046	135
322	2.507856	2.507991	2.508125	2.508260	2.508395	135
323	2.509202	2.509337	2.509471	2.509606	2.509740	134
324	2.510545	2.510679	2.510813	2.510947	2.511081	134
325	2.511883	2.512017	2.512150	2.512284	2.512417	133
326	2.513218	2.513351	2.513484	2.513617	2.513750	133
327	2.514548	2.514680	2.514813	2.514946	2.515079	133
328	2.515874	2.516006	2.516139	2.516271	2.516403	132
329	2.517196	2.517328	2.517460	2.517592	2.517724	132
330	2.518514	2.518645	2.518777	2.518909	2.519040	132
331	2.519828	2.519959	2.520090	2.520221	2.520352	131
332	2.521138	2.521269	2.521400	2.521530	2.521661	131
333	2.522444	2.522575	2.522705	2.522835	2.522966	130
334	2.523746	2.523876	2.524006	2.524136	2.524266	130
335	2.525045	2.525174	2.525304	2.525433	2.525563	130
336	2.526339	2.526468	2.526598	2.526727	2.526856	129
337	2.527630	2.527759	2.527888	2.528016	2.528145	129
338	2.528917	2.529045	2.529174	2.529302	2.529430	128
339	2.530200	2.530328	2.530456	2.530584	2.530712	128
340	2.531479	2.531607	2.531734	2.531862	2.531989	128
341	2.532754	2.532882	2.533009	2.533136	2.533263	127
342	2.534026	2.534153	2.534280	2.534407	2.534534	127
343	2.535294	2.535421	2.535547	2.535674	2.535800	126
344	2.536558	2.536685	2.536811	2.536937	2.537063	126
345	2.537819	2.537945	2.538071	2.538197	2.538322	126
346	2.539076	2.539202	2.539327	2.539452	2.539578	125
347	2.540329	2.540455	2.540580	2.540705	2.540830	125
348	2.541579	2.541704	2.541829	2.541953	2.542078	125
349	2.542825	2.542950	2.543074	2.543199	2.543323	124
350	2.544068	2.544192	2.544316	2.544440	2.544564	124
351	2.545307	2.545431	2.545554	2.545678	2.545802	124
352	2.546543	2.546666	2.546789	2.546913	2.547036	123
353	2.547775	2.547898	2.548021	2.548144	2.548266	123
354	2.549003	2.549126	2.549249	2.549371	2.549494	123
355	2.550228	2.550351	2.550473	2.550595	2.550717	122
356	2.551450	2.551572	2.551694	2.551816	2.551938	122
357	2.552668	2.552790	2.552911	2.553033	2.553154	121

Num	5	6	7	8	9	Diff.
315	2.498999	2.499137	2.499275	2.499412	2.499550	138
316	2.500374	2.500511	2.500648	2.500785	2.500922	137
317	2.501744	2.501880	2.502017	2.502154	2.502290	137
318	2.503109	2.503246	2.503382	2.503518	2.503654	136
319	2.504471	2.504607	2.504743	2.504878	2.505014	136
320	2.505828	2.505963	2.506099	2.506234	2.506370	136
321	2.507181	2.507316	2.507451	2.507586	2.507721	135
322	2.508530	2.508664	2.508799	2.508933	2.509068	135
323	2.509874	2.510008	2.510143	2.510277	2.510411	134
324	[illegible]	2.511348	2.511482	2.511616	2.511750	.134
325	2.512551	2.512084	2.512818	2.512951	2.513084	133
326	2.513883	2.514016	2.514149	2.514282	2.514415	133
327	2.515211	2.515344	2.515476	2.515609	2.515741	133
328	2.516535	2.516668	2.516800	2.516932	2.517064	132
329	2.517855	2.517987	2.518119	2.518251	2.518382	132
320	2.519171	2.519303	2.519434	2.519565	2.519697	132
331	2.520483	2.520614	2.520745	2.520876	2.521007	131
332	2.521792	2.521922	2.522053	2.522183	2.522314	131
333	2.523096	2.523226	2.523356	2.523486	2.523616	130
334	2.524396	2.524526	2.524656	2.524785	2.524915	130
335	2.525692	2.525822	2.525951	2.526081	2.526210	129
336	2 526985	2.527114	2.527243	2.527372	2.527501	129
337	2.528274	2.528402	2.528531	2.528660	2,528788	129
338	2.529559	2.529687	2.529815	2.529943	2.530072	128
339	2.530840	2.530968	2.531095	2.531223	2,531351	128
340	2.532117	2.532245	2.532372	2.532500	2.532627	128
341	2.533391	2.533518	2.533645	2.533772	2.533899	127
342	2.534661	2.534787	2.534914	2.535041	2.535167	127
343	2.535927	2.536053	2.536179	2.536306	2.536432	126
344	2.537189	2.537315	2,537441	2.537567	2.537693	126
345	2.558448	2.538574	2.538699	2.538825	2.538951	126
346	2.539703	2.539829	2.539954	2.540079	2.540204	125
347	2.540955	2.541080	2.541205	2.541330	2.541454	125
348	2.542203	2.542327	2.542452	2,542576	2.542701	125
349	2.543447	2.543571	2.543696	2.543820	2.543944	124
350	2.544688	2.544812	2.544936	2.545060	2.545183	124
351	2.545925	2.546049	2.546172	2.546296	2.546419	124
352	2.547159	2,547282	2.547405	2.547529	2.547652	123
353	2.548389	2.548512	2.548635	2.548758	2.548881	123
354	2.549616	2.549739	2.549861	2.549984	2.550106	123
355	2.550840	2.550962	2.551084	2.551206	2.551328	122
356	2.552059	2.552181	2.552303	2.552425	2.552546	122
357	2 553276	2.553397	2.553519	2.553640	2.553762	121

Num	0	1	2	3	4	Diff.
358	2.553883	2.554004	2.554126	2.554247	2.554368	121
359	2.555094	2.555215	2.555336	2.555457	2.555578	121
360	2.556302	2.556423	2.556544	2.556664	2.556785	121
361	2.557507	2.557627	2.557748	2.557868	2.557988	12
362	2.558709	2.558828	2.558948	2.559068	2.559188	12
363	2.559907	2.560026	2.560146	2.560265	2.560385	12
364	2.561101	2.561221	2.561340	2.561459	2.561578	11
365	2.562293	2.562412	2 562531	2.562650	2.562768	11
366	2.563481	2,563600	2.563718	2.563837	2.563955	11
367	2.564666	2.564784	2.564903	2.565021	2.565139	11
368	2.565848	2.565966	2.566084	2 566202	2.566320	11
369	2 567026	2.567144	2.567262	2.567379	2.567497	11
370	2.568202	2.568319	2.568436	2.568554	2.568671	11
371	2.569374	2.569491	2.569608	2.569725	2 569842	11
372	2.570543	2.570660	2.570776	2.570893	2.571010	11
373	2.571709	2.571825	2.571942	2.572058	2.572174	11
374	2.572872	2.572988	2 573104	2.573220	2.573336	11
375	2.574031	2.574147	2.574263	2.574379	2.574494	11
376	2.575188	2.575303	2 575419	2 575534	2.575650	11
377	2.576341	2.576456	2.576572	2.576687	2.576802	11
378	2.577492	2.577607	2 577721	2.577836	2.577951	11
379	2.578639	2.578754	2.578868	2.578983	2.579097	11
380	2.579784	2.579898	2.580012	2.580126	2.580240	11
381	2.580925	2.581039	2.581153	2.581267	2.581381	11
382	2.582063	2.582177	2.582291	2.582404	2.582518	11
383	2.583199	2.583312	2.583425	2.583539	2.583652	11
384	2 584331	2.584444	2.584557	2.584670	2.584783	11
385	2.585461	2.585573	2.585686	2.585799	2.585912	11
386	2.586587	2.586700	2.586812	2.586925	2.587037	11
387	2.587711	2.587823	2.587935	2.588047	2.588160	11
388	2.588832	2.588944	2.589055	2.589167	2.589279	11
389	2.589950	2.590061	2.590173	2.590284	2.590396	11
390	2.591065	2.591176	2.591287	2.591398	2.591510	11
391	2.592177	2.592288	2.592399	2.592510	2.592621	11
392	2.593286	2.593397	2.593508	2.593618	2.593729	11
393	2.594392	2.594503	2.594613	2.594724	2.594834	11
394	2.595496	2.595606	2.595717	2.595827	2.595937	11
395	2.596597	2.596707	2.596817	2.596927	2.597037	11
396	2.597695	2.597805	2.597914	2.598024	2.598134	11
397	2.598790	2.598900	2.599009	2.599119	2.599228	10
398	2.599883	2.599992	2.600101	2.600210	2.600319	10
399	2.600973	2.601082	2.601190	2.601299	2.601408	10
400	2.602060	2.602168	2.602277	2.602386	2.602494	10

Num	5	6	7	8	9	Diff.
358	2.554489	2.554610	2.554731	2.554852	2.554937	121
359	2.555699	2.555820	2.555940	2.556061	2.556182	121
360	2.556905	2.557026	2.557146	2.557266	2.557387	121
361	2.558108	2.558228	2.558348	2.558469	2.558589	120
362	2.559308	2.559428	2.559548	2.559667	2.559787	120
363	2.560504	2.560624	2.560743	2.560863	2.560982	119
364	2.561697	2.561817	2.561936	2.562055	2.562174	119
365	2.562887	2.563006	2.563125	2.563244	2.563362	119
366	2.564074	2.564192	2.564311	2.564429	2.564548	119
367	2,565257	2.565375	2.565494	2.565612	2.565730	118
368	2.566437	2.566555	2.566673	2.566791	2.566909	118
369	2.567614	2.567732	2.567849	2.567967	2.568084	118
370	2.568788	2.568905	2.569023	2.569140	2.569257	117
371	2.569959	2.570076	2.570193	2.570309	2.570426	117
372	2.571126	2.571243	2.571359	2.571476	2.571592	117
373	2.572291	2.572407	2.572523	2.572639	2.572755	116
374	2.573452	2.573568	2.573684	2.573800	2.573915	116
375	2.574610	2.574726	2.574841	2.574957	2.575072	116
376	2.575765	2.575880	2.575996	2.576111	2.576226	115
377	2.576917	2.577032	2.577147	2.577262	2.577377	115
378	2.578066	2.578181	2.578295	2.578410	2.578525	115
379	2 579212	2.579326	2.579441	2.579555	2.579669	114
380	2.580355	2.580469	2.580583	2.580697	2.580811	114
381	2.581495	2 581608	2.581722	2.581836	2.581950	114
382	2.582631	2.582745	2.582858	2.582972	2,583085	114
383	2.583765	2.583879	2.583992	2.584105	2.584218	113
384	2.584896	2.585009	2.585122	2.585235	2.585348	113
385	2.586024	2.586137	2.586250	2.586362	2.586475	113
386	2.587149	2.587262	2.587374	2.587486	2.587599	112
387	2.588272	2.588384	2,588496	2.588608	2 588720	112
388	2.589391	2.589503	2.589614	2.589726	2.589838	112
389	2.590507	2.590619	2.590730	2.590842	2.590953	112
390	2.591621	2.591732	2.591843	2.591955	2.592066	111
391	2.592732	2.592843	2.592954	2,593064	2.593175	111
392	2.593840	2.593950	2.594061	2,594171	2.594282	111
393	2.594945	2.595055	2.595165	2.595276	2.595386	110
394	2.596047	2.596157	2.596267	2 596377	2.596487	110
395	2.597146	2,597256	2.597366	2.597476	2.597585	110
396	2.598243	2 598353	2.598462	2.598572	2.598681	110
397	2,599337	2.599446	2.599556	2.599665	2.599774	109
398	2.600428	2.600537	2.600646	2.600755	2 600864	109
399	2.601517	2.601625	2.601734	2.601843	2.601951	109
400	2 602602	2.602711	2.602819	2.602928	2.603036	108

Num	0	1	2	3	4	Diff.
401	2.603144	2,603253	2.603361	2.603469	2.603577	108
402	2.604226	2.604334	2.604442	2 604550	2.604658	108
403	2.605305	2.605413	2.605520	2.605628	2 605736	108
404	2.606381	2.606489	2.606596	2.606704	2.606811	107
405	2 607455	2.607562	2.607669	2.607777	2.607884	107
406	2.608526	2.608633	2.608740	2.608847	2.608954	107
407	2.609594	2.609701	2.609808	2.609914	2.610021	107
408	2.610660	2.610767	2.610873	2.610979	2.611086	106
409	2.611723	2.611829	2.611936	2.612042	2.612148	106
410	2 612784	2.612890	2.612996	2.613102	2.613208	106
411	2.613842	2,613947	2.614053	2 614159	2.614264	106
412	2.614897	2.615003	2.615108	2.615213	2.615319	105
413	2.615950	2.616055	2 616160	2.616265	2.616370	105
414	2.617000	2.617105	2.617210	2.617315	2.617420	105
415	2 618048	2.618153	2 618257	2.618362	2.618466	105
416	2.619093	2.619198	2.619302	2.619406	2.619511	104
417	2.620136	2.620240	2.620344	2 620448	2.620552	104
418	2.621176	2.621280	2.621384	2 621488	2.621592	104
419	2.622214	2.622318	2,622421	2.622525	2.622628	104
420	2.623249	2.623353	2.623456	2 623559	2.623663	103
421	2.624282	2.624385	2.624488	2.624591	2.624694	103
422	2.625312	2 625415	2.625518	2.625621	2.625724	103
423	2.626340	2.626443	2.626546	2.626648	2.626751	103
424	2.627366	2.627468	2.627571	2.627673	2.627775	102
425	2.628389	2.628491	2.628593	2,628695	2.628797	102
426	2.629410	2.629511	2.629613	2.629715	2.629817	102
427	2 630428	2.630529	2.630631	2.630733	2 630834	102
428	2,631444	2 631545	2.631647	2.631748	2.631849	101
429	2.632457	2.632558	2.632660	2.632761	2.632862	101
430	2.633468	2.633569	2.633670	2 633771	2.633872	101
431	2.634477	2.634578	2.634679	2.634779	2.634880	100
432	2.635484	2.635584	2.635685	2.635785	2.635886	100
433	2.636488	2.636588	2.636688	2.636789	2.636889	100
434	2.637490	2.637590	2.637690	2.637790	2.637890	100
435	2.638489	2.638589	2.638689	2.638789	2.638888	99
436	2.639486	2.639586	2,639686	2.639785	2.639885	99
437	2.640481	2.640581	2.640680	2.640779	2.640879	99
438	2.641474	2.641573	2.641672	2.641771	2.641870	99
439	2.642464	2.642563	2.642662	2.642761	2.642860	99
440	2.643453	2.643551	2.643650	2.643749	2 643847	98
441	2.644439	2.644537	2.644635	2.644734	2.644832	98
442	2,645422	2.645520	2.645619	2.645717	2.645815	98
443	2.646404	2.646502	2.646600	2.646698	2.646796	98

Num	5	6	7	8	9	Diff.
401	2.603685	2.603794	2.603902	2.604010	2.604118	108
402	2.604766	2.604874	2.604982	2.605089	2.605197	108
403	2.605843	2.605951	2.606059	2.606166	2.606274	108
404	2.606918	2.607026	2.607133	2.607240	2.607348	107
405	2.607991	2.608098	2.608205	2.608312	2.608419	107
406	2.609060	2.609167	2.609274	2.609381	2.609488	107
407	2.610128	2.610244	2.610341	2.610447	2.610554	107
408	2.611192	2.611298	2.611405	2.611511	2.611617	106
409	2.612254	2.612360	2.612466	2.612572	2.612678	106
410	2.613313	2.613419	2.613525	2.613630	2.613736	106
411	2.614370	2.614475	2.614581	2.614686	2.614792	106
412	2.615424	2.615529	2.615634	2.615740	2.615845	105
413	2.616475	2.616580	2.616685	2.616790	2.616895	105
414	2.617524	2.617629	2.617734	2.617839	2.617943	105
415	2.618571	2.618675	2.618780	2.618884	2.618989	105
416	2.619615	2.619719	2.619823	2.619928	2.620032	104
417	2.620656	2.620760	2.620864	2.620968	2.621072	104
418	2.621695	2.621799	2.621903	2.622007	2.622110	104
419	2.622732	2.622835	2.622939	2.623042	2.623146	104
420	2.623766	2.623869	2.623972	2.624076	2.624179	103
421	2.624798	2.624901	2.625004	2.625107	2.625209	103
422	2.625827	2.625929	2.626032	2.626135	2.626238	103
423	2.626853	2.626956	2.627058	2.627161	2.627263	103
424	2.627878	2.627980	2.628082	2.628184	2.628287	102
425	2.628900	2.629002	2.629104	2.629206	2.629308	102
426	2.629919	2.630021	2.630123	2.630224	2.630326	102
427	2.630936	2.631038	2.631139	2.631241	2.631342	102
428	2.631951	2.632052	2.632153	2.632255	2.632356	101
429	2.632963	2.633064	2.633165	2.633266	2.633367	101
430	2.633973	2.634074	2.634175	2.634276	2.634376	100
431	2.634981	2.635081	2.635182	2.635283	2.635383	100
432	2.635986	2.636086	2.636187	2.636287	2.636388	100
433	2.636989	2.637089	2.637189	2.637289	2.637390	100
434	2.637990	2.638090	2.638190	2.638289	2.638389	99
435	2.638988	2.639088	2.639188	2.639287	2.639387	99
436	2.639984	2.640084	2.640183	2.640283	2.640382	99
437	2.640978	2.641077	2.641176	2.641276	2.641375	99
438	2.641970	2.642069	2.642168	2.642267	2.642366	99
439	2.642959	2.643058	2.643156	2.643255	2.643354	99
440	2.643946	2.644044	2.644143	2.644242	2.644340	98
441	2.644931	2.645029	2.645127	2.645226	2.645324	98
442	2.645913	2.646011	2.646109	2.646208	2.646306	98
443	2.646894	2.646991	2.647089	2.647187	2.647285	98

Num	0	1	2	3	4	Diff.
444	2.647383	2,647481	2.647578	2.647676	2.647774	98
445	2.648360	2.648458	2.648555	2.648653	2.648750	97
446	2.649335	2.649432	2.649530	2.649627	2.649724	97
447	2.650307	2.650405	2.650502	2.650599	2.650696	97
448	2.651278	2.651375	2.651472	2.651569	2.651666	97
449	2.652246	2.652343	2.652440	2.652536	2.652633	97
450	2.653212	2.653309	2.653405	2.653502	2.653598	96
451	2.654176	2.654273	2.654369	2.654465	2.654562	96
452	2.655138	2.655234	2.655331	2.655427	2.655523	96
453	2.656098	2.656194	2.656290	2.656386	2.656481	96
454	2.657056	2,657151	2.657247	2.657343	2.657438	96
455	2.658011	2.658107	2.658202	2.658298	2.658393	95
456	2.658965	2.659060	2.659155	2.659250	2.659346	95
457	2.659916	2.660011	2.660106	2.660201	2.660296	95
458	2.660865	2.660960	2.661055	2.661150	2.661245	95
459	2.661813	2.661907	2.662002	2.662096	2.662191	95
460	2.662758	2.662852	2.662947	2.663041	2.663135	94
461	2.663701	2.663795	2.663889	2.663983	2.664078	94
462	2.664642	2,664736	2.664830	2.664924	2.665018	94
463	2.665581	2.665675	2.665768	2.665862	2.665956	94
464	2.666518	2.666612	2.666705	2.666799	2.666892	94
465	2.667453	2.667546	2.667640	2.667733	2.667826	93
466	2.668386	2.668479	2.668572	2.668665	2.668758	93
467	2.669317	2.669410	2.669503	2.669596	2.669689	93
468	2.670246	2.670339	2.670431	2.670524	2.670617	93
469	2.671173	2.671265	2.671358	2.671451	2.671543	93
470	2.672098	2.672190	2.672283	2.672375	2.672467	92
471	2,673021	2.673113	2.673205	2.673297	2.673390	92
472	2.673942	2.674034	2.674126	2.674218	2.674310	92
473	2.674861	2.674953	2.675045	2.675136	2.675228	92
474	2.675778	2.675870	2.675961	2.676053	2.676145	92
475	2.676694	2.676785	2.676876	2.676968	2.677059	91
476	2.677607	2.677698	2.677789	2.677881	2.677972	91
477	2.678518	2.678609	2.678700	2.678791	2.678882	91
478	2.679428	2.679519	2.679610	2.679700	2.679791	91
479	2.680335	2.680426	2.680517	2.680607	2.680698	91
480	2.681241	2.681332	2.681422	2.681513	2.681603	90
481	2.682145	2.682235	2.682326	2.682416	2.682506	90
482	2.683047	2.683137	2.683227	2.683317	2.683407	90
483	2.683947	2.684037	2.684127	2.684217	2.684307	90
484	2.684845	2.684935	2.685025	2.685114	2.685204	90
485	2.685742	2.685831	2.685921	2.686010	2.686100	89
486	2.686636	2.686726	2.686815	2.686904	2.686994	89

Num	5	6	7	8	9	Diff
444	2.647872	2.647969	2.648067	2.648165	2.648202	98
445	2.648848	2.648945	2.649043	2.649140	2.649237	97
446	2.649821	2.649919	2.650016	2.650113	2.650210	97
447	2.650793	2.650890	2.650987	2.651084	2.651181	97
448	2.651762	2 651859	2.651956	2.652053	2.652150	97
449	2.652730	2.652826	2.652923	2.653019	2.653116	97
450	2.653695	2.653791	2.653888	2.653984	2.654080	96
451	2.654658	2.654754	2.654850	2.654946	2.655042	96
452	2.655619	2.655714	2.655810	2.655906	2.656002	96
453	2.656577	2 656673	2.656769	2.656864	2.656960	96
454	2.657534	2.657629	2.657725	2.657820	2.657916	96
455	2.658488	2.658584	2.658679	2.658774	2.658870	95
456	2.659441	2.659536	2.659631	2.659726	2.659821	95
457	2 660391	2.660486	2.660581	2.660676	2.660771	95
458	2.661339	2.661434	2.661529	2,661623	2.661718	95
459	2.662285	2.662380	2.662474	2,662569	2.662663	95
460	2.663230	2.663324	2.663418	2.663512	2.663607	94
461	2.664172	2.664266	2.664360	2.664454	2.664548	94
462	2.665112	2 665206	2.665299	2.665393	2.665487	94
463	2.666050	2 666143	2.666237	2.666331	2.666424	94
464	2.666986	2.667079	2.667173	2.667266	2,667359	94
465	2.667920	2.668013	8.668106	2.668199	2.668293	93
466	2.668852	2.668945	8.669038	2.669131	2.669224	93
467	2.669782	2.669874	8.669967	2.670060	2,670153	93
468	2.670710	2.670802	8.670895	2.670988	2 671080	93
469	2.671636	2.671728	8.671821	2.671913	2.672005	93
470	2.672560	2.672652	8.672744	2.672836	2.672929	92
471	2.673482	2.673574	8.673666	2.673758	2.673850	92
472	2.674402	2.674494	8.674586	2.674677	2.674769	92
473	2.675320	2.675412	8.675503	2.675595	2.675687	92
474	2.676236	2.676328	8.676419	2.676511	2.676602	92
475	2.677150	2.677242	8.677333	2 677424	2.677516	91
476	2.678063	2.678154	8.678245	2,678336	2.678427	91
477	2.678973	2.679064	8.679155	2.679246	2.679337	91
478	2.679882	2.679973	8.680063	2,680154	2.680245	91
479	2.680789	2.680879	8.680970	2.681060	2.681151	91
480	2.681693	2.681784	8.681874	2,681964	2.682055	90
481	2.682596	2.682686	8.682777	2.682867	2.682957	90
482	2.683497	2.683587	8.683677	2.683767	2.683857	90
483	2.684396	2.684486	8.684576	2.684666	2.684756	90
484	2.685294	2.685383	8.685473	2.685563	2.685653	90
485	2.686189	2.686279	8.686368	2.686457	2.686547	89
486	2.687083	2.687172	8.687261	2.687351	2.687440	89

Num	0	1	2	3	4	D.r.
487	2.687529	2.687618	2.687707	2.687796	2.687885	89
488	2.688420	2.688509	2.688598	2,688687	2.688776	89
489	2.689309	2.689398	2.689486	2.689575	2.689664	89
490	2.690196	2.690285	2.690373	2.690462	2.690550	89
491	2.691081	2.691170	2.691258	2,691347	2.691435	88
492	2.691965	2.692053	2.692142	2.692230	2.692318	88
493	2.692847	2.692935	2.693023	2,693111	2.693199	88
494	2.693727	2.693815	2.693903	2.693991	2.694078	88
495	2.694605	2.694693	2,694781	2.694868	2.694956	88
496	2.695482	2.695569	2.695657	2.695744	2.695832	87
497	2.696356	2.696444	2.696531	2.696618	2.696706	87
498	2.697229	2.697316	2.697404	2.697491	2.697578	87
499	2.698100	2.698188	2.698275	2.698362	2.698448	87
500	2.698970	2.699057	2.699144	2.699230	2.699317	87
501	2.699838	2.699924	2.700011	2.700098	2.700184	87
502	2.700704	2.700790	2.700877	2.700963	2.701050	86
503	2.701568	2.701654	2.701741	2.701827	2.701913	86
504	2.702430	2.702517	2.702603	2.702689	2,702775	86
505	2.703291	2.703377	2.703463	2.703549	2.703635	86
506	2.704150	2.704236	2.704322	2.704408	2.704494	86
507	2.705008	2.705094	2.705179	2.705265	2.705350	86
508	2.705864	2.705949	2.706035	2.706120	2.706205	85
509	2.706718	2.706803	2.706888	2.706974	2.707059	85
510	2.707570	2.707655	2.707740	2.707826	2.707911	85
511	2.708421	2.708506	2.708591	2.708676	2.708761	85
512	2.709270	2.709355	2.709440	2.709524	2,709609	85
513	2.710117	2.710202	2.710287	2.710371	2.710456	85
514	2.710963	2.711048	2.711132	2.711216	2.711301	84
515	2.711807	2.711891	2.711976	2.712060	2.712144	84
516	2.712650	2.712734	2.712818	2.712902	2.712986	84
517	2.713490	2.713574	2.713658	2.713742	2.713826	84
518	2.714330	2.714414	2.714497	2.714581	2.714665	84
519	2.715167	2.715251	2.715335	2.715418	2.715502	84
520	2.716003	2.716087	2.716170	2.716254	2.716337	83
521	2.716838	2.716921	2.717004	2.717088	2.717171	83
522	2.717670	2.717754	2.717837	2.717920	2.718003	83
523	2.718502	2.718585	2.718668	2.718751	2.718834	83
524	2.719331	2.719414	2.719497	2.719580	2,719663	83
525	2.720159	2.720242	2.720325	2,720407	2,720490	83
526	2.720986	2.721068	2.721151	2.721233	2,721316	82
527	2.721811	2.721893	2.721975	2.722058	2.722140	82
528	2.722634	2.722716	2.722798	2 722881	2.722963	82
529	2.723456	2.723538	2.723620	2.723702	2.723784	82

Num	5	6	7	8	9	Diff
487	2.687975	2.688064	2.688153	2.688242	2.688331	89
488	2.688865	2.688953	2.689042	2.689131	2.689220	89
489	2.689753	2.689841	2.689930	2.690019	2.690107	89
490	2.690639	2.690727	2.690816	2.690905	2.690993	89
491	2.691523	2.691612	2.691700	2.691788	2.691877	88
492	2.692406	2.692494	2.692583	2.692671	2.692759	88
493	2.693287	2.693375	2.693463	2.693551	2.693639	88
494	2.694166	2.694254	2.694342	2.694430	2.694517	88
495	2.695044	2.695131	2.695219	2.695306	2.695394	88
496	2.695919	2.696007	2.696094	2.696182	2.696269	87
497	2.696793	2.696880	2.696968	2.697055	2.697142	87
498	2.697665	2.697752	2.697839	2.697926	2.698013	87
499	2.698535	2.698622	2.698709	2.698796	2.698883	87
500	2.699404	2.699491	2.699578	2.699664	2.699751	87
501	2.700271	2.700357	2.700444	2.700531	2.700617	87
502	2.701136	2.701222	2.701309	2.701395	2.701482	86
503	2.701999	2.702086	2.702172	2.702258	2.702344	86
504	2.702861	2.702947	2.703033	2.703119	2.703205	86
505	2.703721	2.703807	2.703893	2.703979	2.704065	86
506	2.704579	2.704665	2.704751	2.704837	2.704922	86
507	2.705436	2.705522	2.705607	2.705693	2.705778	86
508	2.706291	2.706376	2.706462	2.706547	2.706632	85
509	2.707144	2.707229	2.707315	2.707400	2.707485	85
510	2.707996	2.708081	2.708166	2.708251	2.708336	85
511	2.708846	2.708931	2.709015	2.709100	2.709185	85
512	2.709694	2.709779	2.709863	2.709948	2.710033	85
513	2.710540	2.710625	2.710710	2.710794	2.710879	85
514	2.711385	2.711470	2.711554	2.711638	2.711723	84
515	2.712229	2.712313	2.712397	2.712481	2.712565	84
516	2.713070	2.713154	2.713238	2.713322	2.713406	84
517	2.713910	2.713994	2.714078	2.714162	2.714246	84
518	2.714749	2.714832	2.714916	2.715000	2.715084	84
519	2.715580	2.715669	2.715753	2.715836	2.715920	84
520	2.716421	2.716504	2.716588	2.716671	2.716754	83
521	2.717254	2.717338	2.717421	2.717504	2.717587	83
522	2.718086	2.718169	2.718253	2.718336	2.718419	83
523	2.718917	2.719000	2.719083	2.719165	2.719248	83
524	2.719745	2.719828	2.719911	2.719994	2.720077	83
525	2.720573	2.720655	2.720738	2.720821	2.720903	83
526	2.721398	2.721481	2.721563	2.721646	2.721728	82
527	2.722222	2.722305	2.722387	2.722469	2.722552	82
528	2.723045	2.723127	2.723209	2.723291	2.723374	82
529	2.723866	2.723948	2.724030	2.724112	2.724194	82

Num	0	1	2	3	4	Diff,
530	2.724276	2.724358	2.724440	2.724522	2.724603	82
531	2.725094	2.725176	2.725258	2,725340	2.725421	82
532	2.725912	2.725993	2.726075	2.726156	2.726238	82
533	2.726727	2.726809	2.726890	2,726972	2.727053	81
534	2.727541	2.727623	2.727704	2,727785	2.727866	81
535	2.728354	2.728435	2.728516	2.728597	2.728678	81
536	2.729165	2.729246	2.729327	2,729408	2.729489	81
537	2.729974	2.730055	2.730136	2.730217	2.730298	81
538	2.730782	2.730863	2,730944	2.731024	2.731105	81
539	2.731589	2.731669	2.731750	2.731830	2.731911	81
540	2.732394	2.732474	2.732555	2.732635	2.732715	80
541	2.733197	2.733277	2.733358	2.733438	2.733518	80
542	2.733999	2.734079	2.734159	2.734240	2.734320	80
543	2.734800	2.734880	2.734960	2.735040	2.735120	80
544	2.735599	2.735679	2.735758	2.735838	2.735918	80
545	2.736396	2,736476	2.736556	2.736635	2.736715	80
546	2.737193	2.737272	2.737352	2.737431	2.737511	79
547	2.737987	2.738067	2.738146	2.738225	2,738305	79
548	2.738781	2.738860	2.738939	2.739018	2.739097	79
549	2.739572	2.739651	2.739730	2.739810	2.739889	79
550	2 740363	2.740442	2.740521	2,740599	2.740678	79
551	2.741152	2.741230	2.741309	2.741388	2.741467	79
552	2.741939	2.742018	2.742096	2.742175	2.742254	79
553	2.742725	2.742804	2.742882	2.742961	2.743039	78
554	2.743510	2.743588	2.743666	2.743745	2.743823	78
555	2.744293	2.744371	2.744449	2.744528	2.744606	78
556	2.745075	2.745153	2.745231	2.745309	2.745387	78
557	2,745855	2.745933	2.746011	2.746089	2.746167	78
558	2,746634	2.746712	2.746790	2.746868	2.746945	78
559	2.747412	2.747489	2.747567	2.747645	2.747722	78
560	2.748188	2.748266	2.748343	2.748421	2.748498	77
561	2.748963	2.749040	2.749118	2.749195	2.749272	77
562	2.749736	2.749814	2.749891	2.749968	2.750045	77
563	2.750508	2.750586	2.750663	2.750740	2.750817	77
564	2.751279	2.751356	2.751433	2.751510	2.751587	77
565	2.752048	2.752125	2.752202	2.752279	2.752356	77
566	2.752816	2.752893	2.752970	2.753047	2.753123	77
567	2.753583	2.753660	2.753736	2.753813	2,753889	77
568	2.754348	2.754425	2.754501	2,754578	2,754654	77
569	2.755112	2.755189	2.755265	2.755341	2,755417	76
570	2.755875	2.755951	2.756027	2.756103	2.756180	76
571	2.756636	2.756712	2.756788	2 756864	2.756940	76
572	2.757396	2.757472	2.757548	2.757624	2.757700	76

um	5	6	7	8	9	Dif.
30	2.724685	2.724767	2.724849	2.724931	2.725013	82
31	2.725503	2.725585	2.725667	2.725748	2.725830	82
32	2.726320	2.726401	2.726483	2.726564	2.726646	82
33	2.727134	2.727216	2.727297	2.727379	2.727460	81
34	2.727948	2.728029	2.728110	2.728191	2.728273	81
35	2.728759	2.728841	2.728922	2.729003	2.729084	81
36	2.729570	2.729651	2.729732	2.729813	2.729893	81
37	2.730378	2.730459	2.730540	2.730621	2.730702	81
38	2.731186	2.731266	2.731347	2.731428	2.731508	81
39	2.731991	2.732072	2.732152	2.732233	2.732313	81
40	2.732796	2.732876	2.732956	2.733037	2.733117	80
41	2.733598	2.733679	2.733759	2.733839	2.733919	80
42	2.734400	2.734480	2.734560	2.734640	2.734720	80
43	2.735200	2.735279	2.735359	2.735439	2.735519	80
44	2.735998	2.736078	2.736157	2.736237	2.736317	80
45	2.736795	2.736874	2.736954	2.737034	2.737113	80
46	2.737590	2.737670	2.737749	2.737829	2.737908	79
47	2.738384	2.738463	2.738543	2.738622	2.738701	79
48	2.739177	2.739256	2.739335	2.739414	2.739493	79
49	2.739968	2.740047	2.740126	2.740205	2.740284	79
50	2.740757	2.740836	2.740915	2.740994	2.741073	79
51	2.741546	2.741624	2.741703	2.741782	2.741860	79
52	2.742333	2.742411	2.742489	2.742568	2.742647	79
53	2.743118	2.743196	2.743275	2.743353	2.743431	78
54	2.743902	2.743980	2.744058	2.744136	2.744215	78
55	2.744684	2.744762	2.744840	2.744919	2.744997	78
56	2.745465	2.745543	2.745621	2.745699	2.745777	78
57	2.746245	2.746323	2.746401	2.746479	2.746556	78
58	2.747023	2.747101	2.747179	2.747256	2.747334	78
59	2.747800	2.747878	2.747955	2.748033	2.748110	78
60	2.748576	2.748653	2.748731	2.748808	2.748885	77
61	2.749350	2.749427	2.749504	2.749582	2.749659	77
62	2.750123	2.750200	2.750277	2.750354	2.750431	77
63	2.750894	2.750971	2.751048	2.751125	2.751202	77
64	2.751664	2.751741	2.751818	2.751895	2.751972	77
65	2.752433	2.752509	2.752586	2.752663	2.752740	77
66	2.753200	2.753277	2.753353	2.753430	2.753506	77
67	2.753966	2.754042	2.754119	2.754195	2.754272	77
68	2.754730	2.754807	2.754883	2.754960	2.755036	77
69	2.755494	2.755570	2.755646	2.755722	2.755799	76
70	2.756256	2.756332	2.756408	2.756484	2.756560	76
71	2.757016	2.757092	2.757168	2.757244	2.757320	76
72	2.757775	2.757851	2.757927	2.758003	2.758079	76

Num	0	1	2	3	4	Dif
573	2.758155	2.758230	2.758306	2.758382	2.758458	76
574	2.758912	2.758988	2.759063	2.759139	2.759214	76
575	2.759668	2.759743	2.759819	2.759894	2.759970	75
576	2.760422	2.760498	2.760573	2.760649	2.760724	75
577	2.761176	2.761251	2.761326	2.761402	2.761477	75
578	2.761928	2.762003	2.762078	2.762153	2.762228	75
579	2.762679	2.762754	2.762829	2.762904	2.762978	75
580	2.763428	2.763503	2.763578	2.763652	2.763727	75
581	2.764176	2.764251	2.764326	2.764400	2.764475	75
582	2.764923	2.764998	2.765072	2.765147	2.765221	75
583	2.765669	2.765743	2.765818	2 765892	2.765966	74
584	2 766413	2.766487	2.766562	2.766636	2.766710	74
585	2.767156	2.767230	2.767304	2.767379	2.767453	74
586	2.767898	2.767972	2.768046	2.768120	2.768194	74
587	2.768638	2.768712	2.768786	2.768860	2 768934	74
588	2.769377	2.769451	2.769525	2.769599	2.769673	74
589	2.770115	2.770189	2.770263	2.770336	2.770410	74
590	2.770852	2.770926	2.770999	2.771073	2.771146	74
591	2.771587	2.771661	2.771734	2.771808	2.771881	73
592	2.772322	2.772395	2.772468	2.772542	2.772615	73
593	2.773055	2.773128	2.773201	2.773274	2.773348	73
594	2.773786	2.773860	2.773933	2.774006	2.774079	73
595	2.774517	2.774590	2.774663	2.774736	2.774809	73
596	2.775246	2.775319	2.775392	2.775465	2.775538	73
597	2.775974	2.776047	2.776120	2.776193	2.776265	73
598	2.776701	2.776774	2.776846	2.776919	2.776992	73
599	2.777427	2.777499	2 777572	2.777644	2.777717	72
600	2.778151	2.778224	2.778296	2.778368	2.778441	72
601	2.778874	2.778947	2.779019	2.779001	2.779163	72
602	2.779596	2.779669	2.779741	2.779813	2.779885	72
603	2.780317	2.780389	2.780461	2.780533	2.780605	72
604	2.781037	2.781109	2.781181	2.781253	2.781324	72
605	2.781755	2.781827	2.781899	2.781971	2.782042	72
606	2.782473	2.782544	2.782616	2.782688	2.782759	72
607	2.783189	2.783260	2.783332	2.783403	2.783475	71
608	2.783904	2.783975	2.784046	2.784118	2.784189	71
609	2.784617	2.784689	2.784760	2.784831	2.784902	71
610	2.785330	2.785401	2.785472	2.785543	2.785615	71
611	2.786041	2.786112	2.786183	2.786254	2.786325	71
612	2.786751	2.786822	2.786893	2.786964	2.787035	71
613	2.787460	2.787531	2.787602	2.787673	2.787744	71
614	2.788168	2.788239	2.788310	2.788381	2.788451	71
615	2.788875	2.788946	2.789016	2.789087	2.789158	71

Num	5	6	7	8	9	Diff.
573	2.758533	2.758609	2.758685	2.758761	2.758836	76
574	2.759290	2.759366	2.759441	2.759517	2.759592	76
575	2.760045	2.760121	2.760196	2.760272	2.760347	75
576	2.760799	2.760875	2.760950	2.761025	2.761101	75
577	2.761552	2.761627	2.761702	2.761778	2.761853	75
578	2.762303	2.762378	2.762453	2.762529	2.762604	75
579	2.763053	2.763128	2.763203	2.763278	2.763353	75
580	2.763802	2.763877	2.763952	2.764027	2.764101	75
581	2.764550	2.764624	2.764699	2.764774	2.764848	75
582	2.765296	2.765370	2.765445	2.765520	2.765594	75
583	2.766041	2.766115	2.766190	2.766264	2.766338	74
584	2.766785	2.766859	2.766933	2.767007	2.767082	74
585	2.767527	2.767601	2.767675	2.767749	2.767823	74
586	2.768268	2.768342	2.768416	2.768490	2.768564	74
587	2.769008	2.769082	2.769156	2.769230	2.769303	74
588	2.769746	2.769820	2.769894	2.769968	2.770042	74
589	2.770484	2.770557	2.770631	2.770705	2.770778	74
590	2.771220	2.771293	2.771367	2.771440	2.771514	74
591	2.771955	2.772028	2.772102	2.772175	2.772248	73
592	2.772688	2.772762	2.772835	2.772908	2.772981	73
593	2.773421	2.773494	2.773567	2.773640	2.773713	73
594	2.774152	2.774225	2.774298	2.774371	2.774444	73
595	2.774882	2.774955	2.775028	2.775100	2.775173	73
596	2.775610	2.775683	2.775756	2.775829	2.775902	73
597	2.776338	2.776411	2.776483	2.776556	2.776629	73
598	2.777064	2.777137	2.777209	2.777282	2.777354	73
599	2.777789	2.777862	2.777934	2.778006	2.778079	72
600	2.778513	2.778585	2.778658	2.778730	2.778802	72
601	2.779236	2.779308	2.779380	2.779452	2.779524	72
602	2.779957	2.780029	2.780101	2.780173	2.780245	72
603	2.780677	2.780749	2.780821	2.780893	2.780965	72
604	2.781396	2.781468	2.781540	2.781612	2.781684	72
605	2.782114	2.782186	2.782258	2.782329	2.782401	72
606	2.782831	2.782902	2.782974	2.783046	2.783117	72
607	2.783546	2.783618	2.783689	2.783761	2.783832	71
608	2.784261	2.784332	2.784403	2.784475	2.784546	71
609	2.784974	2.785045	2.785116	2.785187	2.785259	71
610	2.785686	2.785757	2.785828	2.785899	2.785970	71
611	2.786396	2.786467	2.786538	2.786609	2.786680	71
612	2.787106	2.787177	2.787248	2.787319	2.787390	71
613	2.787815	2.787885	2.787956	2.788027	2.788098	71
614	2.788522	2.788593	2.788663	2.988734	2.788804	71
615	2.789228	2.789299	2.789369	2.789440	2.789510	71

Num	0	1	2	3	4	Dif
616	2.789581	2.789651	2.789722	2.789792	2.789863	70
617	2.790285	2.790356	2.790426	2.790496	2.790567	70
618	2.790989	2.791059	2.791129	2.791199	2.791269	70
619	2.791691	2.791761	2.791831	2.791901	2.791971	70
620	2.792392	2.792462	2.792532	2.792602	2.792672	70
621	2.793092	2.793162	2.793231	2.793301	2.793371	70
622	2.793790	2.793860	2.793930	2.794000	2.794070	70
623	2.794488	2.794558	2.794627	2.794697	2.794767	70
624	2.795185	2.795254	2.795324	2.795393	2.795463	69
625	2.795880	2.795949	2.796019	2.796088	2.796158	69
626	2.796574	2.796644	2.796713	2.796782	2.796852	69
627	2 797268	2.797337	2.797406	2.797475	2.797545	69
628	2.797960	2.798029	2.798098	2.798167	2.798237	69
629	2.798651	2.798720	2.798789	2.798858	2.798927	69
630	2.[illegible]9341	2.799409	2.799478	2.799547	2.799616	69
631	2.800029	2.800098	2.800166	2.800236	2.800305	69
632	2.800717	2.800786	2.800854	2.800923	2.800992	69
633	2.801404	2.801472	2.801541	2.801609	2.801678	69
634	2.802089	2.802158	2.802226	2.802295	2.802363	68
635	2.802774	2.802842	2.802910	2.802979	2.803047	68
636	2.803457	2.803525	2.803594	2.803662	2.803730	68
637	2.804139	2.804208	2.804276	2.804344	2.804412	68
638	2.804821	2.804889	2.804957	2.805025	2.805093	68
639	2.805501	2.805569	2.805637	2.805705	2.805773	68
640	2.806180	2.806248	2.806316	2.806384	2.806451	68
641	2.806858	2.806926	2.806994	2.807061	2.807129	68
642	2.807535	2.807603	2 807670	2.807738	2.807806	68
643	2.808211	2.808279	2.808346	2.808414	2.808481	67
644	2.808886	2.808953	2.809021	2.809088	2.809155	67
645	2.809560	2.809627	2.809694	2.809762	2.809829	67
646	2.810233	2.810300	2.810367	2.810434	2.810501	67
647	2.810904	2.810971	2.811038	2.811106	2.811173	67
648	2.811575	2.811642	2.811709	2.811776	2.811843	67
649	2.812245	2.812312	2.812378	2.812445	2.812512	67
650	2.812913	2.812980	2.813047	2.813114	2.813180	67
651	2.813581	2.813648	2.813714	2.813781	2.813848	67
652	2.814248	2.814314	2.814381	2.814447	2.814514	67
653	2.814913	2.814980	2.815046	2.815113	2.815179	66
654	2.815578	2.815644	2.815710	2.815777	2.815843	66
655	2.816241	2.816308	2.816374	2.816440	2.816506	66
656	2.816904	2.816970	2.817036	2.817102	2.817169	66
657	2.817565	2.817631	2.817698	2.817764	2.817830	66
658	2.818226	2.818292	2.818358	2.818424	2.818490	66

um	5	6	7	8	9	Diff
16	2.799933	2.780003	2.790074	2.790144	2.790215	70
17	2.790637	2.790707	2.790778	2.790848	2.790918	70
18	2.791340	2.791410	2.791480	2.791550	2.791620	70
19	2.792041	2.792111	2.792181	2.792252	2.792322	70
20	2.792742	2 792812	2.792882	2.792952	2.793022	70
21	2.793441	2.793511	2.793581	2.793651	2.793721	70
22	2.794139	2.794209	2.794279	2.794349	2.794418	70
23	2.794836	2.794906	2.794976	2.795045	2.795115	70
24	2.795532	2.795602	2.795671	2.795741	2.795810	69
25	2.796227	2.796297	2.796366	2.796436	2.796505	69
26	2.796921	2.796990	2.797060	2.797129	2.797198	69
27	2.797614	2.797683	2.797752	2,797821	2.797890	69
28	2.798305	2.798374	2.798443	2,798512	2.798582	69
29	2 798996	2.799065	2.799134	2.799203	2.799272	69
30	2.799685	2.799754	2.799823	2.799892	2.799960	69
31	2.800373	2.800442	2.800511	2,800580	2.800648	69
32	2.801060	2 801129	2.801198	2.801267	2.801335	69
33	2.801747	2 801815	2.801884	2.801952	2.802021	69
34	2.802432	2.802500	2.802568	2.802637	2.802705	68
35	2.803116	2.803184	2.803252	2.803321	2.803389	68
36	2.803798	2.803867	2.803935	2.804003	2.804071	68
37	2.804480	2.804548	2.804616	2.804685	2.804753	68
38	2.805161	2.805229	2.805297	2.805365	2.805433	68
39	2.805840	2.805908	2.805976	2.806044	2.806112	68
40	2.806519	2.806587	2.806655	2.806723	2 806790	68
41	2.807197	2.807264	2.807332	2.807400	2.807467	68
42	2.807873	2.807941	2.808008	2.808076	2.808143	68
43	2.808548	2.808616	2.808683	2.808751	2.808818	67
44	2.809223	2.809290	2.809358	2.809425	2.809492	67
45	2.809896	2.809963	2.810031	2.810098	2.810165	67
46	2.810568	2.810636	2.810703	2.810770	2.810837	67
47	2.811240	2.811307	2.811374	2 811441	2.811508	67
48	2.811910	2.811977	2.812044	2,812111	2.812178	67
49	2.812579	2.812646	2.812713	2.812780	2.812846	67
50	2.813247	2.813314	2.813381	2,813447	2.813514	67
51	2.813914	2.813981	2.814048	2.814114	2.814181	67
52	2.814580	2.814647	2.814714	2.814780	2.814847	67
53	2.815246	2.815312	2.815378	2.815445	2.815511	66
54	2.815910	2.815976	2.816042	2.816109	2.816175	66
55	2.816573	2.816639	2.816705	2.816771	2.816838	66
656	2.817235	2.817301	2.817367	2.817433	2.817499	66
637	2.817896	2.817962	2.818028	2.818094	2.818160	66
658	2.818556	2.818622	2.818688	2.818754	2.818819	66

Num	0	1	2	3	4	Diff.
659	2.818885	2.818951	2.819017	2.819083	2.819149	66
660	2.819544	2.819610	2.819675	2.819741	2.819807	66
661	2.820201	2.820267	2.820333	2.820398	2.820464	66
662	2.820858	2.820924	2.820989	2.821055	2.821120	66
663	2.821513	2.821579	2.821644	2.821710	2.821775	65
664	2.822168	2.822233	2.822299	2.822364	2.822430	65
665	2.822822	2.822887	2.822952	2.823017	2.823083	65
666	2.823474	2.823539	2.823605	2.823670	2.823735	65
667	2.824126	2.824191	2.824256	2.824321	2.824386	65
668	2.824776	2.824841	2.824906	2.824971	2.825036	65
669	2.825426	2.825491	2.825556	2.825621	2.825686	65
670	2.826075	2.826140	2.826204	2.826269	2.826334	65
671	2.826722	2.826787	2.826852	2.826917	2.826981	65
672	2.827369	2.827434	2.827498	2.827563	2.827628	65
673	2.828015	2.828080	2.828144	2.828209	2.828273	64
674	2.828660	2.828724	2.828789	2.828853	2.828918	64
675	2.829304	2.829368	2.829432	2.829497	2.829561	64
676	2.829947	2.830011	2.830075	2.830139	2.830204	64
677	2.830589	2.830653	2.830717	2.830781	2.830845	64
678	2.831230	2.831294	2.831358	2.831422	2.831486	64
679	2.831870	2.831934	2.831998	2.832062	2.832125	64
680	2.832509	2.832573	2.832637	2.832700	2.832764	64
681	2.833147	2.833211	2.833275	2.833338	2.833402	64
682	2.833784	2.833848	2.833912	2.833975	2.834039	64
683	2.834421	2.834484	2.834548	2.834611	2.834675	64
684	2.835056	2.835120	2.835183	2.835246	2.835310	63
685	2.835691	2.835754	2.835817	2.835881	2.835944	63
686	2.836324	2.836387	2.836451	2.836514	2.836577	63
687	2.836957	2.837020	2.837083	2.837146	2.837209	63
688	2.837588	2.837652	2.837715	2.837778	2.837841	63
689	2.838219	2.838282	2.838345	2.838408	2.838471	63
690	2.838849	2.838912	2.838975	2.839038	2.839101	63
691	2.839478	2.839541	2.839604	2.839667	2.839729	63
692	2.840106	2.840169	2.840232	2.840294	2.840357	63
693	2.840733	2.840796	2.840859	2.840921	2.840984	63
694	2.841359	2.841422	2.841485	2.841547	2.841610	63
695	2.841985	2.842047	2.842110	2.842172	2.842235	62
696	2.842609	2.842672	2.842734	2.842796	2.842859	62
697	2.843233	2.843295	2.843357	2.843420	2.843482	62
698	2.843855	2.843918	2.843980	2.844042	2.844104	62
699	2.844477	2.844539	2.844601	2.844663	2.844726	62
700	2.845098	2.845160	2.845222	2.845284	2.845346	62
701	2.845718	2.845780	2.845842	2.845904	2.845966	62

um	5	6	7	8	9	Diff
59	2.819215	2.819281	2.819346	2.819412	2.819478	66
60	2.819873	2.819939	2.820004	2.820070	2.820136	66
61	2.820530	2.820595	2.820661	2.820727	2.820792	66
62	2.821186	2.821251	2.821317	2.821382	2.821448	66
63	2.821841	2.821906	2.821972	2.822037	2.822103	65
64	2.822495	2.822560	2.822626	2.822691	2.822756	65
65	2.823148	2.823213	2.823279	2.823344	2.823409	65
66	2.823800	2.823865	2.823930	2.823996	2.824061	65
67	2.824451	2.824516	2.824581	2.824646	2.824711	65
68	2.825101	2 825166	2.825231	2.825296	2.825361	65
669	2.825751	2.825815	2.825880	2.825945	2.826010	65
670	2.826399	2.826464	2.826528	2,826593	2.826658	65
671	2.827046	2.827111	2.827175	2,827240	2.827305	65
672	2 827692	2.827757	2.827821	2.827886	2.827950	65
673	2.828338	2.828402	2.828467	2.828531	2.828595	64
674	2.828982	2.829046	2.829111	2,829175	2.829239	64
675	2.829625	2.829690	2.829754	2.829818	2.829882	64
676	2.830268	2 830332	2.830396	2.830460	2.830524	64
677	2.830909	2 830973	2.831037	2.831102	2.831166	64
678	2.831550	2.831614	2.831678	2.831742	2.831806	64
679	2.832189	2.832253	2.832317	2.832381	2.832445	64
680	2.832828	2.832892	2.832956	2.833019	2.833083	64
681	2.833466	2.833530	2.833593	2.833657	2.833721	64
682	2.834103	2.834166	2.834230	2.834293	2.834357	64
683	2.834738	2.834802	2.834866	2.834929	2 834993	64
684	2.835373	2.835437	2.835500	2.835564	2.835627	63
685	2.836007	2.836071	2.836134	2.836197	2.836261	63
686	2.836640	2.836704	2.836767	2.836830	2.836893	63
687	2.837273	2.837336	2.837399	2.837462	2.837525	63
688	2.837904	2.837967	2.838030	2.838093	2.838156	63
689	2.838534	2.838597	2.838660	2.838723	2.838786	63
690	2.839164	2.839227	2.839289	2 839352	2.839415	63
691	2.839792	2.839855	2.839918	2,839981	2.840043	63
692	2.840420	2.840482	2.840545	2.840608	2.840671	63
693	2.841046	2.841109	2.841172	2,841234	2.841297	63
694	2.841672	2.841735	2.841797	2.841860	2.841922	63
695	2.842297	2.842360	2.842422	2,842484	2.842547	62
696	2.842921	2.842983	2.843046	2.843108	2.843170	62
697	2.843544	2.843606	2.843669	2.843731	2.843793	62
698	2.844166	2.844229	2.844291	2.844353	2.844415	62
699	2.844788	2.844850	2.844912	2.844974	2.845036	62
700	2.845408	2.845470	2.845532	2.845594	2.845656	62
701	2.846028	2.846090	2.846151	2.846213	2.846275	62

Num	0	1	2	3	4	Diff.
702	2.846337	2.846399	2.846461	2.846523	2.846584	62
703	2.846955	2.847017	2.847079	2.847141	2.847202	62
704	2.847573	2.847634	2.847696	2.847758	2.847819	62
705	2.848189	2.848251	2.848312	2.848374	2.848435	62
706	2.848805	2.848866	2.848928	2.848989	2.849051	61
707	2.849419	2.849481	2.849542	2.849604	2.849665	61
708	2.850033	2.850095	2.850156	2.850217	2.850279	61
709	2.850646	2.850707	2.850769	2.850830	2.850891	61
710	2.851258	2.851319	2.851381	2.851442	2.851503	61
711	2.851870	2.851931	2.851992	2.852053	2.852114	61
712	2.852480	2.852541	2.852602	2.852663	2.852724	61
713	2.853089	2.853150	2.853211	2.853272	2.853333	61
714	2.853698	2.853759	2.853820	2.853881	2.853941	61
715	2.854306	2.854367	2.854427	2.854488	2.854549	61
716	2.854913	2.854974	2.855034	2.855095	2.855156	61
717	2.855519	2.855580	2.855640	2.855701	2.855761	60
718	2.856124	2.856185	2.856245	2.856306	2.856366	60
719	2.856729	2.856789	2.856850	2.856910	2.856970	60
720	2.857332	2.857393	2.857453	2.857513	2.857574	60
721	2.857935	2.857995	2.858056	2.858116	2.858176	60
722	2.858537	2.858597	2.858657	2.858718	2.858778	60
723	2.859138	2.859198	2.859258	2.859318	2.859378	60
724	2.859739	2.859798	2.859858	2.859918	2.859978	60
725	2.860338	2.860398	2.860458	2.860518	2.860578	60
726	2.860937	2.860996	2.861056	2.861116	2.861176	60
727	2.861534	2.861594	2.861654	2.861714	2.861773	60
728	2.862131	2.862191	2.862251	2.862310	2.862370	60
729	2.862727	2.862787	2.862847	2.862906	2.862966	60
730	2.863323	2.863382	2.863442	2.863501	2.863561	59
731	2.863917	2.863977	2.864036	2.864096	2.864155	59
732	2.864511	2.864570	2.864630	2.864689	2.864748	59
733	2.865104	2.865163	2.865222	2.865282	2.865341	59
734	2.865696	2.865755	2.865814	2.865873	2.865933	59
735	2.866287	2.866346	2.866405	2.866465	2.866524	59
736	2.866878	2.866937	2.866996	2.867055	2.867114	59
737	2.867467	2.867526	2.867585	2.867644	2.867703	59
738	2.868056	2.868115	2.868174	2.868233	2.868292	59
739	2.868644	2.868703	2.868762	2.868821	2.868879	59
740	2.869232	2.869290	2.869349	2.869408	2.869466	59
741	2.869818	2.869877	2.869935	2.869994	2.870053	59
742	2.870404	2.870462	2.870521	2.870579	2.870638	58
743	2.870989	2.871047	2.871106	2.871164	2.871223	58
744	2.871573	2.871631	2.871690	2.871748	2.871806	58

Num	5	6	7	8	9	Diff.
702	2.846646	2.846708	2.846770	2.846832	2.846893	62
703	2.847264	2.847326	2.847388	2.847449	2.847511	62
704	2.847881	2.847943	2.848004	2.848066	2.848127	62
705	2.848497	2.848559	2.848620	2.848682	2.848743	62
706	2.849112	2.849174	2.849235	2.849296	2.849358	61
707	2.849726	2.849788	2.849849	2.849911	2.849972	61
708	2.850340	2.850401	2.850462	2,850524	2.850585	61
709	2.850952	2.851014	2.851075	2.851136	2.851197	61
710	2.851564	2.851625	2.851686	2.851747	2.851808	61
711	2,852175	2.852236	2.852297	2.852358	2.852419	61
712	2.852785	2.852846	2.852907	2.852968	2.853029	61
713	2.853394	2.853455	2.853516	2.853576	2.853637	61
714	2.854002	2.854063	2.854124	2.854184	2.854245	61
715	2.854610	2.854670	2.854731	2.854792	2.854852	61
716	2.855216	2.855277	2.855337	2.855398	2.855459	61
717	2.855822	2.855882	2.855943	2.856003	2.856064	60
718	2.856427	2.856487	2.856548	2.856608	2.856668	60
719	2.857031	2.857091	2.857151	2.857212	2.857272	60
720	2.857634	2.857694	2.857754	2.857815	2.857875	60
721	2.858236	2.858296	2.858357	2.858417	2.858477	60
722	2.858838	2.858898	2.858958	2.859018	2.859078	60
723	2 859438	2.859498	2.859559	2.859619	2.859679	60
724	2.860038	2.860098	2.860158	2.860218	2,860278	60
725	2.860637	2.860697	2.860757	2.860817	2.860877	60
726	2.861236	2.861295	2.861355	2.861415	2,861475	60
727	2.861833	2.861893	2.861952	2.862012	2.862072	60
728	2.862430	2.862489	2.862549	2.862608	2.862668	60
729	2.863025	2.863085	2.863144	2.863204	2.863263	60
730	2.863620	2.863680	2.863739	2.863798	2.863858	59
731	2.864214	2.864274	2,864333	2.864392	2.864452	59
732	2.864808	2.864867	2.864926	2.864985	2.865045	59
733	2.865400	2.865459	2.865518	2.865578	2.865637	59
734	2.865992	2.866051	2.866110	2.866169	2.866228	59
735	2.866583	2.866642	2.866701	2.866760	2.866819	59
736	2.867173	2.867232	2.867291	2.867350	2.867409	59
737	2.867762	2,867821	2.867880	2.867939	2.867997	59
738	2.868350	2.868409	2.868468	2.868527	2.868586	59
739	2.868938	2.868997	2.869056	2.869114	2.869173	59
740	2.869525	2.869584	2.869642	2.869701	2.869760	59
741	2.870111	2.870170	2.870228	2.870287	2.870345	59
742	2.870696	2.870755	2.870813	2,870872	2.870930	58
743	2 871281	2.871339	2.871398	2,871456	2.871515	58
744	28,71865	2.871923	2.871981	2.872040	2.872098	58

Num	0	1	2	3	4	Diff.
745	2.872156	2.872215	2.872273	2.872331	2.872389	58
746	2.872739	2.872797	2.872855	2.872913	2.872972	58
747	2.873321	2.873379	2.873437	2.873495	2.873553	58
748	2.873902	2.873960	2.874018	2.874076	2.874134	58
749	2.874482	2.874540	2.874598	2.874656	2.874714	58
750	2.875061	2.875119	2.875177	2.875235	2.875293	58
751	2.875640	2.875698	2.875756	2.875815	2.875871	58
752	2.876218	2.876276	2.876333	2.876391	2.876449	58
753	2.876795	2.876853	2.876910	2.876968	2.877026	58
754	2.877371	2.877429	2.877486	2.877544	2.877602	58
755	2.877947	2.878004	2.878062	2.878119	2.878177	57
756	2.878522	2.878579	2.878637	2.878694	2.878751	57
757	2.879096	2.879153	2.879211	2.879268	2.879325	57
758	2.879669	2.879726	2.879784	2.879841	2.879898	57
759	2.880242	2.880299	2.880356	2.880413	2.880471	57
760	2.880814	2.880871	2.880928	2.880985	2.881042	57
761	2.881385	2.881442	2.881499	2.881556	2.881613	57
762	2.881955	2.882012	2.882069	2.882126	2.882183	57
763	2.882524	2.882581	2.882638	2.882695	2.882752	57
764	2.883093	2.883150	2.883207	2.883264	2.883321	57
765	2.883661	2.883718	2.883775	2.883832	2.883889	57
766	2.884229	2.884285	2.884342	2.884399	2.884455	57
767	2.884795	2.884852	2.884909	2.884965	2.885022	57
768	2.885361	2.885418	2.885474	2.885531	2.885587	57
769	2.885926	2.885983	2.886039	2.886096	2.886152	56
770	2.886491	2.886547	2.886603	2.886660	2.886716	56
771	2.887054	2.887111	2.887167	2.887223	2.887280	56
772	2.887617	2.887673	2.887730	2.887786	2.887842	56
773	2.888179	2.888236	2.888292	2.888348	2.888404	56
774	2.888741	2.888797	2.888853	2.888909	2.888965	56
775	2.889302	2.889358	2.889414	2.889470	2.889526	56
776	2.889862	2.889918	2.889974	2.890030	2.890086	56
777	2.890421	2.890477	2.890533	2.890586	2.890644	56
778	2.890980	2.891035	2.891091	2.891147	2.891203	56
779	2.891537	2.891593	2.891649	2.891705	2.891760	56
780	2.892095	2.892150	2.892206	2.892262	2.892317	56
781	2.892651	2.892707	2.892762	2.892818	2.892873	56
782	2.893207	2.893262	2.893318	2.893373	2.893429	56
783	2.893762	2.893817	2.893873	2.893928	2.893984	55
784	2.894316	2.894371	2.894427	2.894482	2.894538	55
785	2.894870	2.894925	2.894980	2.895036	2.895091	55
786	2.895422	2.895478	2.895533	2.895588	2.895643	55
787	2.895975	2.896030	2.896085	2.896140	2.896195	55

Num	5	6	7	8	9	Diff.
745	2.872448	2.872506	2.872564	2.872622	2.872681	58
746	2.873030	2.873088	2.873146	2.873204	2.873262	58
747	2.873611	2.873669	2.873727	2.873785	2.873843	58
748	2.874192	2.874250	2.874308	2.874366	2.874424	58
749	2.874772	2.874830	2.874887	2.874945	2.875003	58
750	2.875351	2.875409	2.875466	2.875524	2.875582	58
751	2.875929	2.875987	2.876045	2.876102	2.876160	58
752	2.876506	2.876564	2.876622	2.876680	2.876737	58
753	2.877083	2.877141	2.877198	2.877256	2.877314	58
754	2,877659	2.877717	2.877774	2.877832	2.877889	58
755	2.878234	2.878292	2.878349	2.878407	2.878464	57
756	2.878809	2.878866	2.878924	2.878981	2.879038	57
757	2.879383	2.879440	2.879497	2.879555	2.879612	57
758	2.879956	2.880013	2.880070	2.880127	2.880185	57
759	2.880528	2.880585	2.880642	2.880699	2.880756	57
760	2.881099	2.881156	2.881213	2.881270	2.881328	57
761	2.881670	2.881727	2.881784	2.881841	2.881898	57
762	2.882240	2.882297	2·882354	2.882411	2.882468	57
763	2.882809	2.882866	2·882923	2.882980	2.883036	57
764	2.883377	2.883434	2.883491	2.883548	2.883605	57
765	2.883945	2.884002	2.884059	2.884115	2.884172	57
766	2 884512	2.884569	2.884625	2.884682	2.884739	57
767	2.885078	2.885135	2.885191	2.885248	2.885305	57
768	2.885644	2.885700	2.885757	2 885813	2.885870	57
769	2.886209	2.886265	2.886321	2.886378	2.886434	56
770	2.886773	2.886829	2.886885	2.886942	2.886998	56
771	2.887336	2.887392	2.887448	2.887505	2.887561	57
772	2.887898	2.887955	2.888011	2.888068	2.888123	56
773	2.888460	2.888516	2.888573	2.888629	2.888685	56
774	2.889021	2.889077	2,889134	2.889190	2.889246	56
775	2.889582	2.889638	2.889694	2.889750	2 889806	56
776	2.890141	2.890197	2.890253	2.890309	2.890365	56
777	2.890700	2.890756	2.890812	2.890868	2.890924	56
778	2.891259	2.891314	2.891370	2,891426	2.891482	56
779	2.891816	2.891872	2.891927	2,891983	2.892039	56
780	2.892373	2,892428	2.892484	2.892540	2.892595	56
781	2.892929	2.892985	2.893040	2 893096	2.893151	56
782	2.893484	2.893540	2.893595	2.893651	2.893706	56
783	2.894039	2.894094	2.894150	2.894205	2.894261	55
784	2,894593	2.894648	2.894704	2.894759	2.894814	55
785	2.895146	2.895201	2.895257	2.895312	2.895367	55
786	2.895699	2.895754	2.895809	2.895864	2.895919	55
787	2 896251	2.896306	2.896361	2.896416	2.896471	55

Num	0	1	2	3	4	Diff
788	2.896526	2.896581	2.896636	2.896691	2.896747	55
789	2.897077	2.897132	2.897187	2.897242	2.897297	55
790	2.897627	2.897682	2.897737	2.897792	2.897847	55
791	2.898176	2.898231	2.898286	2.898341	2.898396	55
792	2.898725	2.898780	2.898835	2.898890	2.898944	55
793	2.899273	2.899328	2.899383	2.899437	2.899492	55
794	2.899820	2.899875	2.899930	2.899985	2.900039	55
795	2.900367	2.900422	2.900476	2.900531	2.900586	55
796	2.900913	2.900968	2.901022	2.901077	2.901131	55
797	2.901458	2.901513	2.901567	2.901622	2.901676	55
798	2.902003	2.902057	2.902112	2.902166	2.902220	54
799	2.902547	2.902601	2.902655	2.902710	2.902764	54
800	2.903090	2.903144	2.903198	2.903253	2.903307	54
801	2.903632	2.903687	2.903741	2.903795	2.903849	54
802	2.904174	2.904228	2 904283	2.904337	2.904391	54
803	2.904715	2.904770	2.904824	2.904878	2.904931	54
804	2.905256	2.905310	2.905364	2 905418	2.905472	54
805	2.905796	2.905850	2.905904	2.905958	2.906012	54
806	2.906335	2.906389	2.906443	2.906497	2.906550	54
807	2.906873	2.906927	2.906981	2 907035	2.907089	54
808	2.907411	2.907465	2.907519	2.907573	2.907626	54
809	2.907948	2 908002	2.908056	2.908109	2.908163	54
810	2.908485	2.908539	2.908592	2.908646	2.908699	54
811	2.909021	2.909074	2.909128	2.909181	2.909235	53
812	2.909556	2.909609	2.909663	2.909716	2.909770	53
813	2.910090	2.910144	2.910197	2.910251	2.910304	53
814	2.910624	2.910678	2.910731	2.910784	2.910838	53
815	2.911158	2 911211	2.911264	2.911317	2.911371	53
816	2.911690	2.911743	2.911797	2.911850	2.911903	53
817	2.912222	2.912275	2.912328	2.912381	2.912435	53
818	2 912753	2.912806	2.912859	2.912912	2.912966	53
819	2.913284	2.913337	2.913390	2.913443	2.913496	53
820	2.913814	2.913867	2.913920	2.913973	2.914026	53
821	2.914343	2.914369	2.914449	2.914502	2.914555	53
822	2.914872	2.914925	2.914977	2.915030	2.915083	53
823	2.915400	2.915453	2.915505	2.915558	2.915611	53
824	2.915927	2.915980	2.916033	2.916085	2.916138	53
825	2.916454	2.916507	2.916559	2.916612	2.916664	53
826	2.916980	2.917033	2.917085	2.917138	2.917190	53
827	2.917505	2.917558	2.917610	2.917663	2.917715	52
828	2.918030	2.918083	2.918135	2.918188	2.918240	52
829	2.918555	2.918607	2.918659	2.918712	2.918764	52
830	2.919078	2.919130	2.919183	2.919236	2.919287	52

Num	5	6	7	8	9	Diff
788	2.896802	2.896857	2.896912	2.896967	2.897022	55
789	2.897352	2.897407	2.897462	2.897517	2.897572	55
790	2.897902	2.897957	2.898012	2.898067	2.898122	55
791	2.898451	2.898506	2.898561	2.898615	2.898670	55
792	2.898999	2.899054	2.899109	2.899164	2.899218	55
793	2.899547	2.899602	2.899656	2.899711	2.899766	55
794	2.900094	2.900149	2.900203	2.900258	2.900312	55
795	2.900640	2.900695	2.900749	2.900804	2.900858	55
796	2.901186	2.901240	2.901295	2.901349	2.901404	55
797	2.901731	2.901785	2.901840	2.901894	2.901948	54
798	2.902275	2.902329	2.902384	2.902438	2.902492	54
799	2.902818	2.902873	2.902927	2.902981	2.903036	54
800	2.903361	2.903416	2.903470	2.903524	2.903578	54
801	2.903903	2.903958	2.904012	2.904066	2.904120	54
802	2.904445	2.904499	2.904553	2.904607	2.904661	54
803	2.904986	2·905040	2.905094	2.905148	2.905202	54
804	2.905526	2.905580	2.905634	2.905688	2.905742	54
805	2.906065	2.906119	2.906173	2.906227	2.906281	54
806	2.906004	2.906658	2.906712	2.906766	2.906820	54
807	2.907142	2.907196	2.907250	2.907304	2.907358	54
808	2.907680	2.907734	2.907787	2.907841	2.907895	54
809	2.908217	2.908270	2.908324	2.908378	2.908431	54
810	2.908753	2.908807	2.908860	2.908914	2.908967	54
811	2.909288	2.909342	2.909395	2.909419	2.909502	54
812	2.909823	2.909877	2.909930	2.909984	2.910037	53
813	2.910358	2.910411	2.910464	2.910518	2.910571	53
814	2.910891	2.910944	2.910998	2.911051	2.911104	53
815	2.911424	2.911477	2.911530	2.911584	2.911637	53
816	2.911956	2.912009	2.912063	2.912116	2.912169	53
817	2.912488	2.912541	2.912594	2.912647	2.912700	53
818	2.913019	2.913072	2.913125	2.913178	2.913231	53
819	2.913549	2.913602	2.913655	2.913708	2.913761	53
820	2.914079	2.914131	2.914184	2.914237	2.914290	53
821	2.914608	2.914660	2.914713	2.914766	2.914819	53
822	2.915136	2.915189	2.915241	2.915294	2.915347	53
823	2.915664	2.915716	2.915769	2.915822	2.915874	53
824	2.916191	2.916243	2.916296	2.916349	2.916401	53
825	2.916717	2.916770	2.916822	2.916875	2.916927	53
826	2.917243	2.917295	2.917348	2.917400	2.917453	53
827	2.917768	2.917820	2.917873	2.917925	2·917978	52
828	2.918292	2.918345	2.918397	2.918450	2.918502	52
829	2.918816	2.918869	2.918921	2.918973	2.919026	52
830	2.919340	2.919392	2.919444	2.919496	2.919549	52

Num	0	1	2	3	4	Diff.
831	2.919601	2.919653	2.919705	2.919758	2.919810	52
832	2.920123	2.920175	2.920228	2.920280	2.920332	52
833	2,920645	2.920697	2.920749	2.920801	2.920853	52
834	2.921166	2.921218	2.921270	2,921322	2.921374	52
835	2.921686	2.921738	2.921790	2,921842	2.921894	52
836	2.922206	2.922258	2.922310	2.922362	2.922414	52
837	2.922725	2.922777	2.922829	2,922881	2.922933	52
838	2.923244	2.923296	2.923348	2.923399	2.923451	52
839	2.923762	2.923814	2,923865	2,923917	2.923969	52
840	2.924279	2.924331	2.924383	2.924434	2.924486	52
841	2.924796	2.924848	2.924899	2.924951	2.925002	52
842	2.925312	2.925364	2.925415	2.925467	2.925518	52
843	2.925828	2.925879	2.925931	2.925982	2.926034	51
844	2.926342	2.926394	2.926445	2.926497	2.926548	51
845	2.926857	2.926908	2.926959	2.927011	2.927062	51
846	2.927370	2,927422	2.927473	2.927524	2.927576	51
847	2.927883	2,927935	2.927986	2.928037	2.928088	51
848	2.928396	2.928447	2.928498	2.928549	2,928601	51
849	2.928908	2.928959	2.929010	2.929061	2.929112	51
850	2.929419	2.929470	2.929521	2.929572	2.929623	51
851	2.929930	2.929981	2.930032	2.930083	2.930134	51
852	2.930440	2.930491	2.930541	2.930592	2.930643	51
853	2.930949	2.931000	2.931051	2.931102	2.931153	51
854	2.931458	2.931509	2.931560	2.931610	2.931661	51
855	2.931966	2.932017	2.932068	2.932118	2.932169	51
856	2.932474	2.932524	2.932575	2.932626	2.932677	51
857	2.932981	2.933031	2.933082	2.933133	2.933183	51
858	2.933487	2.933538	2.933588	2.933639	2.933690	51
859	2.933993	2.934044	2.934094	2.934145	2.934195	51
860	2.934498	2.934549	2.934599	2.934650	2.934700	50
861	2.935003	2.935054	2.935104	2.935154	2.935205	50
862	2.935507	2.935558	2.935608	2.935658	2.935709	50
863	2.936011	2.936061	2.936111	2.936162	2.936212	50
864	2.936514	2.936564	2.936614	2.936664	2.936715	50
865	2.937016	2.937066	2.937116	2.937167	2.937217	50
866	2.937518	2.937568	2.937618	2.937668	2.937718	50
867	2.938019	2.938069	2.938119	2.938169	2.938219	50
868	2.938520	2.938570	2.938620	2.938670	2,938720	50
869	2.939020	2.939070	2.939120	2,939170	2,939220	50
870	2.939519	2.939569	2.939619	2.939669	2,939719	50
871	2.940018	2.940068	2.940118	2.940168	2.940218	50
872	2.940516	2.940566	2.940616	2 940666	2.940716	50
873	2.941014	2.941064	2.941114	2.941163	2.941213	50

Num	5	6	7	8	9	Diff.
831	2.919862	2.919914	2.919967	2.920019	2.920071	52
832	2.920384	2.920436	2.920489	2.920541	2.920593	52
833	2.920906	2.920958	2.921010	2.921062	2.921114	52
834	2.921426	2.921478	2.921530	2.921582	2.921634	52
835	2.921946	2.921998	2.922050	2.922102	2.922154	52
836	2.922466	2.922518	2.922570	2.922622	2.922674	52
837	2.922985	2.923037	2.923088	2.923140	2.923192	52
838	2.923503	2.923555	2.923607	2.923658	2.923710	52
839	2.924021	2.924072	2.924124	2.924176	2.924228	52
840	2.924538	2.924589	2.924641	2.924693	2.924744	52
841	2.925054	2.925106	2.925157	2.925209	2.925260	52
842	2.925570	2.925621	2.925673	2.925724	2.925776	52
843	2.926085	2.926137	2.926188	2.926239	2.926291	52
844	2.926600	2.926651	2.926702	2.926754	2.926805	51
845	2.927114	2.927165	2.927216	2.927268	2.927319	51
846	2.927627	2.927678	2.927730	2.927781	2.927832	51
847	2.928140	2.928191	2.928242	2.928293	2.928345	51
848	2.928652	2.928703	2.928754	2.928805	2.928856	51
849	2.929163	2.929214	2.929266	2.929317	2.929368	51
850	2.929674	2.929725	2.929776	2.929827	2.929878	51
851	2.930185	2.930236	2.930287	2.930338	2.930389	51
852	2.930694	2.930745	2.930796	2.930847	2.930898	51
853	2.931203	2.931254	2.931305	2.931356	2.931407	51
854	2.931712	2.931763	2.931814	2.931864	2.931915	51
855	2.932220	2.932271	2.932321	2.932372	2.932423	51
856	2.932727	2.932778	2.932829	2.932879	2.932930	51
857	2.933234	2.933285	2.933335	2.933386	2.933437	51
858	2.933740	2.933791	2.933841	2.933892	2.933943	51
859	2.934246	2.934296	2.934347	2.934397	2.934448	51
860	2.934751	2.934801	2.934852	2.934902	2.934953	50
861	2.935255	2.935306	2.935356	2.935406	2.935457	50
862	2.935759	2.935809	2.935860	2.935910	2.935960	50
863	2.936262	2.936313	2.936363	2.936413	2.936463	50
864	2.936765	2.936815	2.936865	2.936916	2.936966	50
865	2.937267	2.937317	2.937367	2.937418	2.937468	50
866	2.937769	2.937819	2.937869	2.937919	2.937969	50
867	2.938269	2.938319	2.938370	2.938420	2.938470	50
868	2.938770	2.938820	2.938870	2.938920	2.938970	50
869	2.939270	2.939319	2.939369	2.939419	2.939469	50
870	2.939769	2.939819	2.939868	2.939918	2.939968	50
871	2.940267	2.940317	2.940367	2.940417	2.940467	50
872	2.940765	2.940815	2.940865	2.940915	2.940965	50
873	2.941263	2.941313	2.941362	2.941412	2.941462	50

Num	0	1	2	3	4	Diff.
874	2.941511	2.941561	2.941611	2.941660	2.941710	50
875	2.942008	2.942058	2.942107	2.942157	2.942206	50
876	2.942504	2.942554	2.942604	2.942653	2.942702	50
877	2.943000	2.943049	2.943099	2.943148	2.943198	49
878	2.943494	2.943544	2.943593	2.943643	2.943692	49
879	2.943989	2.944038	2.944088	2.944137	2.944186	49
880	2.944483	2.944532	2.944581	2.944631	2.944680	49
881	2.944976	2.945025	2.945074	2.945124	2.945173	49
882	2.945469	2.945518	2.945567	2.945616	2.945665	49
883	2.945961	2.946010	2.946059	2.946108	2.946157	49
884	2.946452	2.946501	2.946550	2.946600	2.946649	49
885	2.946943	2.946992	2.947041	2.947090	2.947139	49
886	2.947434	2.947483	2.947532	2.947581	2.947630	49
887	2.947924	2.947973	2.948021	2.948070	2.948119	49
888	2.948413	2.948462	2.948511	2.948560	2.948608	49
889	2.948902	2.948951	2.948999	2.949048	2.949097	49
890	2.949390	2.949439	2.949488	2.949536	2.949585	49
891	2.949878	2.949926	2.949975	2.950024	2.950073	49
892	2.950365	2.950413	2.950462	2.950511	2.950560	49
893	2.950851	2.950900	2.950949	2.950997	2.951046	49
894	2.951337	2.951386	2.951435	2.951483	2.951532	49
895	2.951823	2.951872	2.951920	2.951969	2.952017	49
896	2.952308	2.952356	2.952405	2.952453	2.952502	48
897	2.952792	2.952841	2.952889	2.952938	2.952986	48
898	2.953276	2.953325	2.953373	2.953421	2.953470	48
899	2.953760	2.953808	2.953856	2.953905	2.953953	48
900	2.954242	2.954291	2.954339	2.954387	2.954435	48
901	2.954725	2.954773	2.954821	2.954869	2.954918	48
902	2.955206	2.955255	2.955303	2.955351	2.955399	48
903	2.955688	2.955736	2.955784	2.955832	2.955880	48
904	2.956168	2.956216	2.956264	2.956312	2.956360	48
905	2.956649	2.956697	2.956745	2.956792	2.956840	48
906	2.957128	2.957176	2.957224	2.957272	2.957320	48
907	2.957607	2.957655	2.957703	2.957751	2.957799	48
908	2.958086	2.958134	2.958181	2.958229	2.958277	48
909	2.958564	2.958612	2.958659	2.958707	2.958755	48
910	2.959041	2.959089	2.959137	2.959184	2.959232	48
911	2.959518	2.959566	2.959614	2.959661	2.959709	48
912	2.959995	2.960042	2.960090	2.960138	2.960185	48
913	2.960471	2.960518	2.960566	2.960613	2.960661	48
914	2.960946	2.960994	2.961041	2.961089	2.961136	47
915	2.961421	2.961468	2.961516	2.961563	2.961611	47
916	2.961895	2.961943	2.961990	2.962038	2.962085	47

um	5	6	7	8	9	Diff.
874	2.941760	2.941809	2.941859	2.941909	2.941958	49
875	2.942256	2.942306	2.942355	2.942405	2.942454	49
876	2.942752	2.942801	2.942851	2.942900	2.942950	49
877	2.943247	2.943297	2.943346	2.943396	2.943445	49
878	2.943724	2.943791	2.943841	2.943890	2.943939	49
879	2.944236	2.944285	2.944335	2.944384	2.944433	49
880	2.944729	2.944779	2.944828	2.944877	2.944927	49
881	2.945222	2.945272	2.945321	2.945370	2.945419	49
882	2.945715	2.945764	2.945813	2.945862	2.945911	49
883	2,946207	2.946256	2.946305	2.946354	2.946403	49
884	2.946698	2.946747	2.946796	2.946845	2.946894	49
885	2.947189	2.947238	2.947287	2.947336	2.947385	49
886	2.947679	2.947728	2.947777	2.947826	2.947875	49
887	2.948168	2.948217	2.948266	2.948315	2.948364	49
888	2.948657	2.948706	2.948755	2.948804	2.948853	49
889	2.949146	2.949195	2.949244	2.949292	2.949341	49
890	2.949634	2.949683	2.949731	2.949780	2.949829	49
891	2.950121	2.950170	2.950219	2.950267	2.950316	49
892	2.950608	2.950657	2.950705	2.950754	2.950803	49
893	2.951095	2.951143	2.951192	2.951240	2.951289	49
894	2.951580	2.951629	2.951677	2.951726	2.951774	49
895	2.952066	2.952114	2.952163	2.952211	2.952259	48
896	2.952550	2.952599	2.952647	2.952696	2.952744	48
897	2.953034	2.953083	2.953131	2.953180	2.953228	48
898	2.953518	2.953566	2.953615	2.953663	2,953711	48
899	2.954001	2.954049	2.954098	2.954146	2.954194	48
900	2.954484	2.954532	2.954580	2.954628	2.954677	48
901	2.954966	2.955014	2.955062	2.955110	2.955158	48
902	2.955447	2.955495	2.955543	2.955591	2.955640	48
903	2.955928	2.955976	2,956024	2.956072	2.956120	48
904	2.956409	2.956457	2.956505	2.956553	2.956601	48
905	2.956888	2.956936	2.956984	2.957032	2.957080	48
906	2.957368	2.957416	2.957464	2.957511	2.957559	48
907	2.957847	2.957894	2.957942	2.957990	2.958038	48
908	2.958325	2.958373	2.958420	2.958468	2.958516	48
909	2.958803	2,958850	2.958898	2.958946	2.958994	48
910	2.959280	2.959328	2.959375	2.959423	2.959471	48
911	2.959757	2.959804	2.959852	2.959900	2.959947	48
912	2.960233	2 960281	2.960328	2.960376	2.960423	48
913	2.960709	2.960756	2.960804	2.960851	2.960899	48
914	2.961184	2.961231	2.961279	2,961326	2.961374	47
915	2.961658	2.961706	2.961753	2,961801	2.961848	47
916	2,962132	2.962180	2.962227	2.962275	2.962322	47

Num	0	1	2	3	4	Dif
917	2.962369	2.962417	2.962464	2.962511	2.962559	47
918	2.962843	2.962890	2.962937	2.962985	2.963032	47
919	2.963315	2.963363	2.963410	2.963457	2.963504	47
920	2.963788	2.963835	2.963882	2.963929	2.963977	47
921	2.964260	2.964307	2.964354	2.964401	2.964448	47
922	2.964731	2.964778	2.964825	2.964872	2.964919	47
923	2.965202	2.965249	2.965296	2.965343	2.965390	47
924	2.965672	2.965719	2.965766	2.965813	2.965860	47
925	2.966142	2.966189	2.966236	2.966283	2.966329	47
926	2.966611	2.966658	2.966705	2.966752	2.966798	47
927	2.967080	2.967127	2.967173	2.967220	2.967207	47
928	2.967548	2.967595	2.967642	2.967688	2.967735	47
929	2.968016	2.968062	2.968109	2.968156	2.968203	47
930	2.968483	2.968530	2.968576	2.968623	2.968670	47
931	2.968950	2.968996	2.969043	2.969090	2.969136	47
932	2.969416	2.969462	2.969509	2.969556	2.969602	47
933	2.969882	2.969928	2.969975	2.970021	2.970068	47
934	2.970347	2.970393	2.970440	2.970486	2.970533	4
935	2.970812	2.970858	2.970904	2.970951	2.970997	4
936	2.971276	2.971322	2.971369	2.971415	2.971461	4
937	2.971740	2.971786	2.971832	2.971879	2.971925	4
938	2.972203	2.972249	2.972295	2.972342	2.972388	4
939	2.972666	2.972712	2.972758	2.972804	2.972851	4
940	2.973128	2.973174	2.973220	2.973266	2.973313	4
941	2.973590	2.973636	2.973682	2.973728	2.973774	4
942	2.974051	2.974097	2.974143	2.974189	2.974235	4
943	2.974512	2.974558	2.974604	2.974650	2.974696	4
944	2.974972	2.975018	2.975064	2.975110	2.975156	4
945	2.975432	2.975478	2.975524	2.975570	2.975616	4
946	2.975891	2.975937	2.975983	2.976029	2.976075	4
947	2.976350	2.976396	2.976442	2.976487	2.976533	4
948	2.976808	2.976854	2.976900	2.976946	2.976991	4
949	2.977266	2.977312	2.977358	2.977403	2.977449	4
950	2.977724	2.977769	2.977815	2.977861	2.977906	4
951	2.978180	2.978226	2.978272	2.978317	2.978363	4
952	2.978637	2.978683	2.978728	2.978774	2.978819	4
953	2.979093	2.979138	2.979184	2.979230	2.979275	4
954	2.979548	2.979594	2.979639	2.979685	2.979730	4
955	2.980003	2.980049	2.980094	2.980140	2.980185	4
956	2.980458	2.980503	2.980549	2.980594	2.980640	4
957	2.980912	2.980957	2.981003	2.981048	2.981093	4
958	2.981365	2.981411	2.981456	2.981501	2.981547	4
959	2.981819	2.981864	2.981909	2.981954	2.982000	4

Num	5	6	7	8	9	Diff
917	2.962606	2.962653	2.962701	2.962748	2.962795	47
918	2.963079	2.963126	2.963174	2.963221	2.963268	47
919	2.963552	2.963599	2.963646	2.963693	2.963741	47
920	2.964024	2.964071	2.964118	2.964165	2.964212	47
921	2.964495	2.964542	2.964590	2.964637	2.964684	47
922	2.964966	2.965013	2.965060	2.965108	2.965155	47
923	2.965437	2.965484	2.965531	2.965578	2.965625	47
924	2.965907	2.965954	2.966001	2.966048	2.966095	47
925	2.966376	2.966423	2.966470	2.966517	2.966564	47
926	2.966845	2.966892	2.966939	2.966986	2.967033	47
927	2.967314	2.967361	2.967408	2.967454	2.967501	47
928	2.967782	2.967829	2.967875	2.967922	2.967969	47
929	2.968249	2.968296	2.968343	2.968389	2.968436	47
930	2.968716	2.968763	2.968810	2.968856	2.968903	47
931	2.969183	2.969229	2.969276	2.969323	2.969369	47
932	2.969649	2.969695	2.969742	2.969788	2.969835	47
933	2.970114	2.970161	2.970207	2.970254	2.970300	47
934	2.970579	2.970626	2.970672	2.970719	2.970765	47
935	2.971044	2.971090	2.971137	2.971183	2.971229	46
936	2.971508	2.971554	2.971600	2.971647	2.971693	46
937	2.971971	2.972018	2.972064	2.972110	2.972156	46
938	2.972434	2.972480	2.972527	2.972573	2.972619	46
939	2.972897	2.972943	2.972989	2.973035	2.973082	46
940	2.973359	2.973405	2.973451	2.973497	2.973543	46
941	2.973820	2.973866	2.973913	2.973959	2.974005	46
942	2.974281	2.974327	2.974373	2.974420	2.974466	46
943	2.974742	2.974788	2.974834	2.974880	2.974926	46
944	2.975202	2.975248	2.975294	2.975340	2.975386	46
945	2.975661	2.975707	2.975753	2.975799	2.975845	46
946	2.976121	2.976166	2.976212	2.976258	2.976304	46
947	2.976579	2.976625	2.976671	2.976717	2.976762	46
948	2.977037	2.977083	2.977129	2.977175	2.977220	46
949	2.977495	2.977541	2.977586	2.977632	2.977678	46
950	2.977952	2.977998	2.978043	2.978089	2.978135	46
951	2.978409	2.978454	2.978500	2.978546	2.978591	46
952	2.978865	2.978911	2.978956	2.979002	2.979047	46
953	2.979321	2.979366	2.979412	2.979457	2.979503	46
954	2.979776	2.979821	2.979867	2.979912	2.979958	46
955	2.980231	2.980276	2.980322	2.980367	2.980412	45
956	2.980685	2.980730	2.980776	2.980821	2.980867	45
957	2.981139	2.981184	2.981229	2.981275	2.981320	45
958	2.981592	2.981637	2.981683	2.981728	2.981773	45
959	2.982045	2.982090	2.982135	2.982181	2.982226	45

Num	0	1	2	3	4	Dif
960	2.982271	2.982316	2.982362	2.982407	2.982452	45
961	2.982723	2.982769	2.982814	2.982859	2.982904	45
962	2.983175	2.983220	2.983265	2.983310	2.983356	45
963	2.983626	2.983671	2.983716	2,983762	2.983807	45
964	2.984077	2.984122	2.984167	2,984212	2.984257	45
965	2.984527	2.984572	2.984617	2.984662	2.984707	45
966	2.984977	2.985022	2.985067	2,985112	2.985157	45
967	2.985426	2.985471	2.985516	2.985561	2.985606	45
968	2.985875	2.985920	2.985965	2,986010	2.986055	45
969	2.986324	2.986369	2.986413	2.986458	2.986503	45
970	2.986772	2.986816	2.986861	2,986906	2.986951	45
971	2.987219	2.987264	2.987309	2.987353	2.987398	45
972	2.987666	2.987711	2.987756	2.987800	2.987845	45
973	2.988113	2.988157	2.988202	2.988247	2.988291	45
974	2.988559	2.988603	2.988648	2.988693	2.988737	45
975	2.989005	2.989049	2.989094	2.989138	2.989183	45
976	2.989450	2.989494	2.989539	2.989583	2.989628	44
977	2.989895	2.989939	2.989983	2.990028	2,990072	44
978	2.990339	2.990383	2.990428	2.990472	2.990516	44
979	2.990783	2.990827	2.990871	2.990916	2.990960	44
980	2.991226	2.991270	2.991315	2.991359	2.991403	44
981	2.991669	2.991713	2.991757	2.991802	2.991846	44
982	2.992111	2.992156	2.992200	2.992244	2.992288	44
983	2.992553	2.992598	2.992642	2.992686	2.992730	44
984	2.992995	2.993039	2.993083	2.993127	2.993172	44
985	2.993436	2.993480	2.993524	2.993568	2.993613	44
986	2.993877	2.993921	2.993965	2.994009	2.994053	44
987	2.994317	2.994361	2.994405	2.994449	2.994493	44
988	2.994757	2.994801	2.994845	2.994889	2.994933	44
989	2.995196	2.995240	2.995284	2.995328	2.995372	44
990	2.995635	2.995679	2.995723	2.995767	2.995811	44
991	2.996074	2.996117	2.996161	2.996205	2.996249	44
992	2.996512	2.996555	2.996599	2.996643	2.996687	44
993	2.996949	2.996993	2.997037	2.997080	2.997124	44
994	2.997386	2.997430	2.997474	2.997517	2.997561	44
995	2.997823	2.997367	2.997910	2.997954	2.997998	44
996	2.998259	2.998303	2.998346	2.998390	2.998434	44
997	2.998695	2.998739	2.998782	2.998826	2,998869	44
998	2.999130	2.999174	2.999218	2,999261	2,999305	44
999	2.999565	2.999609	2.999652	2.999696	2,999739	43

Num	5	6	7	8	9	Diff.
960	2.982497	2.982543	2.982588	2.982633	2.982678	45
961	2.982949	2.982994	2.983040	2.983085	2.983130	45
962	2.983401	2.983446	2.983491	2.983536	2.983581	45
963	2.983852	2.983897	2.983942	2.983987	2.984032	45
964	2.984302	2.984347	2.984392	2.984437	2.984482	45
965	2.984752	2.984797	2.984842	2.984887	2.984932	45
966	2.985202	2.985247	2.985292	2.985337	2.985382	45
967	2.985651	2.985696	2.985741	2.985786	2.985830	45
968	2.986100	2.986144	2.986189	2.986234	2.986279	45
969	2.986548	2.986593	2.986637	2.986682	2.986727	45
970	2.986995	2.987040	2.987085	2.987130	2.987174	45
971	2.987443	2.987487	2.987532	2.987577	2.987622	45
972	2.987890	2.987934	2.987979	2.988024	2.988068	45
973	2.988336	2.988381	2.988425	2.988470	2.988514	45
974	2.988782	2.988826	2.988871	2.988915	2.988960	45
975	2.989227	2.989272	2.989361	2.989361	2.989405	45
976	2.989672	2.989717	2.989761	2.989806	2.989850	44
977	2.990117	2.990161	2.990206	2.990250	2.990294	44
978	2.990561	2.990605	2.990650	2.990694	2.990738	44
979	2.991004	2.991049	2.991093	2.991137	2.991182	44
980	2.991448	2.991492	2.991536	2.991580	2.991625	44
981	2.991890	2.991934	2.991979	2.992023	2.992067	44
982	2.992333	2.992377	2.992421	2.992465	2.992509	44
983	2.992774	2.992818	2.992863	2.992907	2.992951	44
984	2.993216	2.993260	2.993304	2.993348	2.993392	44
985	2.993657	2.993701	2.993745	2.993789	2.993833	44
986	2.994097	2.994141	2.994185	2.994229	2.994273	44
987	2.994537	2.994581	2.994625	2.994669	2.994713	44
988	2.994977	2.995021	2.995064	2.995108	2.995152	44
989	2.995416	2.995460	2.995504	2.995547	2.995591	44
990	2.995854	2.995898	2.995942	2.995986	2.996030	44
991	2.996293	2.996336	2.996380	2.996424	2.996468	44
992	2.996730	2.996774	2.996818	2.996862	2.996905	44
993	2.997168	2.997212	2.997255	2.997299	2.997343	44
994	2.997605	2.997648	2.997692	2.997736	2.997779	44
995	2.998041	2.998085	2.998128	2.998172	2.998216	44
996	2.998477	2.998521	2.998564	2.998608	2.998652	44
997	2.998913	2.998956	2.999000	2.999043	2.999087	44
998	2.999348	2.999392	2.999435	2.999478	2.999522	44
999	2.999783	2.999826	2.999870	2.999913	2.999957	43

o Degrees.

Minutes	Sine		Tangent		Secant		
0	0.000000	10 000000	0.000000	Infinite	10.000000	Infinite.	60
1	6.463726	9.999999	6.463726	13.536274	10.000000	13.536274	59
2	6.764756	9.999999	6.764756	13.235244	10.000000	13.235244	58
3	6.940847	9.999999	6.940847	13.059153	10.000000	13.059153	57
4	7.065786	9.999999	7.065786	12.934214	10.000000	12.934214	56
5	7.162696	9.999999	7.162696	12.837304	10.000000	12.837304	55
6	7.241877	9.999999	7.241878	12.758122	10.000001	12.758123	54
7	7.308824	9.999999	7.308825	12.691175	10.000001	12.691176	53
8	7.366816	9.999999	7.366817	12.633183	10.000001	12.633184	52
9	7.417968	9.999999	7.417970	12.582030	10.000001	12.582032	51
10	7.463725	9.999998	7.463727	12.536273	10.000002	12.536275	50
11	7.505118	9.999998	7.505120	12.494880	10.000002	12.494883	49
12	7.542907	9.999997	7.542909	12.457091	10.000003	12.457093	48
13	7.577668	9.999997	7.577671	12.422328	10.000003	12.422332	47
14	7.609853	9.999996	7.609857	12.390143	10.000004	12.390147	46
15	7.639816	9.999996	7.639820	12.360180	10.000004	12.360184	45
16	7.667844	9.999995	7.667849	12.332151	10.000005	12.332156	44
17	7.694173	9.999995	7.694179	12.305821	10.000005	12.305827	43
18	7.718997	9.999994	7.719003	12.280997	10.000006	12.281003	42
19	7.742478	9.999993	7.742484	12.257516	10.000007	12.257522	41
20	7.764754	9.999993	7.764761	12.235239	10.000007	12.235246	40
21	7.785943	9.999992	7.785951	12.214049	10.000008	12.214057	39
22	7.806146	9.999991	7.806155	12.193845	10.000009	12.193854	38
23	7.825451	9.999990	7.825460	12.174540	10.000010	12.174549	37
24	7.843934	9.999989	7.843944	12.156056	10.000011	12.156066	36
25	7.861662	9.999988	7.861674	12.138326	10.000012	12.138338	35
26	7.878695	9.999988	7.878708	12.121292	10.000012	12.121305	34
27	7.895085	9.999987	7.895099	12.104901	10.000013	12.104915	33
28	7.910879	9.999986	7.910894	12.089106	10.000014	12.089121	32
29	7.926119	9.999984	7.926134	12.073866	10.000016	12.073881	31
30	7.940842	9.999083	7.940858	12.059142	10.000017	12.059158	30
		Sine		Tangent		Secant	Minntes

89 Degrees.

0 Degrees.

Sine		Tangent		Secant		
7.940842	9.999984	7.940858	12.059142	10.000016	12.059158	30
7.955082	9.999982	7.955100	12.044900	10.000018	12.044918	29
7.968870	9.999981	7.968889	12.031111	10.000019	12.031130	28
7.982233	9.999980	7.982253	12.017747	10.000020	12.017767	27
7.995198	9.999979	7.995219	12.004781	10.000021	12.004802	26
8.007787	9.999977	8.007809	11.992191	10.000023	11.992213	25
8.020021	9.999976	8.020045	11.979955	10.000024	11.979979	24
8.031919	9.999975	8.031945	11.968055	10.000025	11.968081	23
8.043501	9.999974	8.043527	11.956473	10.000026	11.956499	22
8.054781	9.999972	8.054809	11.945191	10.000028	11.945219	21
8.065776	9.999971	8.065806	11.934194	10.000029	11.934224	20
8.076500	9.999969	8.076531	11.923469	10.000031	11.923500	19
8.086965	9.999968	8.086997	11.913003	10.000032	11.913035	18
8.097183	9.999966	8.097217	11.902783	10.000034	11.902817	17
8.107167	9.999964	8.107202	11.892798	10.000036	11.892833	16
8.116926	9.999963	8.116963	11.883037	10.000037	11.883074	15
8.126471	9.999961	8.126510	11.873490	10.000039	11.873529	14
8.135810	9.999959	8.135851	11.864149	10.000041	11.864190	13
8.144953	9.999958	8.144996	11.855004	10.000042	11.855047	12
8.153908	9.999956	8.153952	11.846048	10.000044	11.846092	11
8.162681	9.999954	8.162727	11.837273	10.000046	11.837319	10
8.171280	9.999952	8.171328	11.828672	10.000048	11.828720	9
8.179713	9.999950	8.179763	11.820237	10.000050	11.820287	8
8.187985	9.999948	8.188036	11.811964	10.000052	11.812015	7
8.196102	9.999946	8.196156	11.803844	10.000054	11.803898	6
8.204070	9.999944	8.204126	11.795874	10.000056	11.795930	5
8.211895	9.999942	8.211953	11.788047	10.000058	11.788105	4
8.219581	9.999940	8.219641	11.780359	10.000060	11.780419	3
8.227134	9.999938	8.227195	11.772805	10.000062	11.772866	2
8.234557	9.999936	8.234621	11.765379	10.000064	11.765443	1
8.241855	9.999934	8.241922	11.758078	10.000066	11.758145	0
	Sine		Tangent		Secant	Minutes

89 Degrees.

1 Degree.

Minutes	Sine		Tangent		Secant		
0	8.241855	9.999934	8.241921	11.758079	10.000066	11.758145	6
1	8.249033	9.999932	8.249102	11.750898	10.000068	11.750967	5
2	8.256094	9.999929	8.256165	11.743835	10.000071	11.743906	5
3	8.263042	9.999927	8.263115	11.736885	10.000073	11.736958	5
4	8.269881	9.999925	8.269956	11.730044	10.000075	11.730119	5
5	8.276614	9.999922	8.276691	11.723309	10.000078	11.723386	5
6	8.283243	9.999920	8.283323	11.716677	10.000080	11.716757	5
7	8.289773	9.999917	8.289856	11.710144	10.000082	11.710227	5
8	8.296207	9.999915	8.296292	11.703708	10.000085	11.703793	5
9	8.302546	9.999912	8.302633	11.697367	10.000087	11.697454	5
10	8.308794	9.999910	8.308884	11.691116	10.000090	11.691206	5
11	8.314954	9.999907	8.315045	11.684954	10.000093	11.685046	4
12	8.321027	9.999905	8.321122	11.678878	10.000095	11.678973	4
13	8.327016	9.999902	8.327114	11.672886	10.000098	11.672984	4
14	8.332924	9.999899	8.333025	11.666975	10.000101	11.667076	4
15	8.338753	9.999897	8.338856	11.661144	10.000103	11.661247	4
16	8.344504	9.999894	8.344610	11.655389	10.000106	11.655496	4
17	8.350180	9.999891	8.350289	11.649710	10.000109	11.649819	4
18	8.355783	9.999888	8.355895	11.644105	10.000112	11.644216	4
19	8.361315	9.999885	8.361430	11.638570	10.000115	11.638685	4
20	8.366777	9.999882	8.366894	11.633105	10.000118	11.633223	4
21	8.372171	9.999879	8.372291	11.627708	10.000121	11.627829	3
22	8.377499	9.999876	8.377622	11.622378	10.000124	11.622501	3
23	8.382762	9.999873	8.382889	11.617111	10.000127	11.617238	3
24	8.387962	9.999870	8.388092	11.611908	10.000130	11.612038	3
25	8.393101	9.999867	8.393234	11.606766	10.000133	11.606899	3
26	8.398179	9.999864	8.398315	11.601685	10.000136	11.601821	3
27	8.403199	9.999861	8.403338	11.596662	10.000139	11.596801	3
28	8.408161	9.999858	8.408304	11.591696	10.000142	11.591839	3
29	8.413068	9.999854	8.413213	11.586787	10.000146	11.586932	3
30	8.417919	9.999851	8.418068	11.581932	10.000149	11.582081	3
		Sine		Tangent		Secant	Minutes

88 Degrees.

1 Degree.

Minutes	Sine		Tangent		Secant		
30	8.417919	9.999851	8.418068	11.581932	10.000149	11.582081	30
31	8.422717	9.999848	8.422869	11.577131	10.000152	11.577283	29
32	8.427462	9.999844	8.427618	11.572382	10.000156	11.572538	28
33	8.432156	9.999841	8.432315	11.567685	10.000159	11.567844	27
34	8.436800	9.999838	8.436962	11.563038	10.000162	11.563200	26
35	8.441394	9.999834	8.441560	11.558440	10.000166	11.558606	25
36	8.445941	9.999831	8.446110	11.553890	10.000169	11.554059	24
37	8.450440	9.999827	8.450613	11.549387	10.000173	11.549560	23
38	8.454893	9.999823	8.455070	11.544930	10.000177	11.545107	22
39	8.459301	9.999820	8.459481	11.540519	10.000180	11.540699	21
40	8.463665	9.999816	8.463849	11.536151	10.000184	11.536335	20
41	8.467985	9.999812	8.468172	11.531827	10.000188	11.532015	19
42	8.472263	9.999809	8.472454	11.527546	10.000191	11.527737	18
43	8.476498	9.999805	8.476693	11.523307	10.000195	11.523502	17
44	8.480693	9.999801	8.480892	11.519108	10.000199	11.519307	16
45	8.484848	9.999797	8.485051	11.514949	10.000203	11.515152	15
46	8.488963	9.999793	8.489170	11.510830	10.000207	11.511037	14
47	8.493040	9.999790	8.493250	11.506750	10.000210	11.506960	13
48	8.497078	9.999786	8.497293	11.502707	10.000214	11.502922	12
49	8.501080	9.999782	8.501298	11.498702	10.000218	11.498920	11
50	8.505045	9.999778	8.505267	11.494733	10.000222	11.494955	10
51	8.508974	9.999774	8.509200	11.490800	10.000226	11.491026	9
52	8.512867	9.999769	8.513098	11.486902	10.000231	11.487133	8
53	8.516726	9.999765	8.516961	11.483039	10.000235	11.483274	7
54	8.520551	9.999761	8.520790	11.479210	10.000239	11.479449	6
55	8.524343	9.999757	8.524586	11.475414	10.000243	11.475657	5
56	8.528102	9.999753	8.528349	11.471651	10.000247	11.471898	4
57	8.531828	9.999748	8.532080	11.467920	10.000252	11.468172	3
58	8.535523	9.999744	8.535779	11.464221	10.002256	11.464477	2
59	8.539186	9.999740	8.539447	11.460553	10.000260	11.460814	1
60	8.542819	9.999735	8.543084	11.456916	10.000265	11.457181	0
		Sine		Tangent		Secant	Minutes

88 Degrees.

2 Degrees.

Minutes	Sine		Tangent		Secant		
0	8.542819	9.999735	8.543084	11.456916	10.000265	11.457181	60
1	8.546422	9.999731	8.546691	11.453309	10.000269	11.453578	59
2	8.549995	9.999727	8.550268	11.449732	10.000273	11.450005	58
3	8.553539	9.999722	8.553817	11.440183	10.000278	11.446461	57
4	8.557054	9.999717	8.557336	11.442664	10.000283	11.442946	56
5	8.560540	9.999713	8.560828	11.439172	10.000287	11.439460	55
6	8.563999	9.999708	8.564291	11.435709	10.000292	11.436001	54
7	8.567431	9.999704	8.567727	11.432273	10.000296	11.432569	53
8	8.570836	9.999699	8.571137	11.428863	10.000301	11.429164	52
9	8.574214	9.999694	8.574520	11.425480	10.000306	11.425786	51
10	8.577566	9.999689	8.577877	11.422123	10.000311	11.422434	50
11	8.580892	9.999685	8.581208	11.418792	10.000315	11.419108	49
12	8.584193	9.999680	8.584514	11.415486	10.000320	11.415807	48
13	8.587469	9.999675	8.587795	11.412205	10.000325	11.412531	47
14	8.590721	9 999670	8.591051	11.408949	10.000330	11.409279	46
15	8.593948	9.999665	8.594283	11.405717	10.000335	11.406052	45
16	8.597152	9.999660	8.597492	11.402508	10.000340	11.402848	44
17	8.600332	9.999655	8.600677	11.399323	10.000345	11.399668	43
18	8.603489	9.999650	8.603839	11.396161	10.000350	11.396511	42
19	8.606623	9.999645	8.606978	11.393022	10.000355	11.393377	41
20	8.609734	9.999640	8.610094	11.389906	10.000360	11.390266	40
21	8.612823	9.999635	8.613189	11.386811	10.000365	11.387177	39
22	8.615891	9.999629	8.616262	11.383738	10.000371	11.384109	38
23	8.618937	9.999624	8.619313	11.380687	10.000376	11.381063	37
24	8.621962	9.999619	8.622343	11.377657	10.000381	11.378038	36
25	8.624965	9.999614	8.625352	11.374648	10.000386	11.375035	35
26	8.627948	9.999608	8.628340	11.371660	10.000392	11.372052	34
27	8.630911	9.999603	8.631308	11.368692	10.000397	11.369089	33
28	8.633854	9.999597	8.634256	11.365744	10.000403	11.366146	32
29	8.636776	9.999592	8.637185	11.362815	10.000408	11.363224	31
30	8.639680	9.999587	8.640093	11.359907	10.000413	11.360320	30
		Sine		Tangent		Secant	Minutes

87 Degrees.

2 Degrees.

Minutes	Sine		Tangent		Secant		
30	8.639680	9.999586	8.640093	11.359907	10.000414	11.360320	30
31	8.642563	9.999581	8.642982	11.357018	10.000419	11.357437	29
32	8.645428	9.999575	8.645853	11.354147	10.000425	11.354572	28
33	8.648274	9.999570	8.648704	11.351296	10.000430	11.351726	27
34	8.651102	9.999564	8.651538	11.348462	10.000436	11.348898	26
35	8.653911	9.999558	8.654352	11.345648	10.000442	11.346089	25
36	8.656702	9.999553	8.657149	11.342851	10.000447	11.343298	24
37	8.659475	9.999547	8.659928	11.340072	10.000453	11.340525	23
38	8.662230	9.999541	8.662689	11.337311	10.000459	11.337770	22
39	8.664968	9.999535	8.665433	11.334567	10.000465	11.335032	21
40	8.667689	9.999529	8.668160	11.331840	10.000471	11.332311	20
41	8.670393	9.999524	8.670870	11.329130	10.000476	11.329607	19
42	8.673080	9.999518	8.673563	11.326437	10.000482	11.326920	18
43	8.675751	9.999512	8.676239	11.323761	10.000488	11.324249	17
44	8.678405	9.999506	8.678900	11.321100	10.000494	11.321595	16
45	8.681043	9.999500	8.681544	11.318456	10.000500	11.318957	15
46	8.683665	9.999494	8.684172	11.315828	10.000506	11.316335	14
47	8.686272	9.999487	8.686784	11.313216	10.000513	11.313728	13
48	8.688863	9.999481	8.689381	11.310618	10.000519	11.311137	12
49	8.691438	9.999475	8.691963	11.308037	10.000525	11.308562	11
50	8.693998	9.999469	8.694529	11.305471	10.000531	11.306002	10
51	8.696543	9.999462	8.697081	11.302919	10.000538	11.303457	9
52	8.699073	9.999456	8.699617	11.300383	10.000544	11.300927	8
53	8.701589	9.999450	8.702139	11.297861	10.000550	11.298411	7
54	8.704090	9.999444	8.704646	11.295354	10.000556	11.295910	6
55	8.706577	9.999437	8.707139	11.292861	10.000563	11.293423	5
56	8.709049	9.999431	8.709619	11.290381	10.000569	11.290951	4
57	8.711508	9.999424	8.712083	11.287917	10.000576	11.288492	3
58	8.713952	9.999418	8.714535	11.285465	10.000582	11.286048	2
59	8.716383	9.999411	8.716972	11.283028	10.000589	11.283617	1
60	8.718800	9.999404	8.719396	11.280604	10.000596	11.281200	0
		Sine		Tangent		Secant	Minutes

87 Degrees.

3 Degrees.

Minutes	Sine		Tangent		Secant		
0	8.718800	9.999404	8.719396	11.280604	10.000596	11.281200	60
1	8.721204	9.999398	8.721806	11.278194	10.000602	11.278796	59
2	8.723595	9.999391	8.724203	11.275797	10.000609	11.276405	58
3	8.725972	9.999384	8.726588	11.273412	10.000616	11.274028	57
4	8.728337	9.999378	8.728959	11.271041	10.000622	11.271663	56
5	8.730688	9.999371	8.731317	11.268683	10.000629	11.269312	55
6	8.733027	9.999364	8.733663	11.266337	10.000636	11.266973	54
7	8.735353	9.999357	8.735996	11.264004	10.000643	11.264647	53
8	8.737668	9.999350	8.738317	11.261683	10.000650	11.262332	52
9	8.739969	9.999343	8.740626	11.259374	10.000657	11.260031	51
10	8.742259	9.999336	8.742922	11.257078	10.000663	11.257741	50
11	8.744536	9.999329	8.745207	11.254793	10.000671	11.255464	49
12	8.746802	9.999322	8.747479	11.252521	10.000678	11.253198	48
13	8.749055	9.999315	8.749740	11.250260	10.000685	11.250945	47
14	8.751297	9.999308	8.751989	11.248011	10.000692	11.248703	46
15	8.753528	9.999301	8.754227	11.245773	10.000699	11.246472	45
16	8.755747	9.999294	8.756453	11.243547	10.000706	11.244253	44
17	8.757955	9.999286	8.758668	11.241332	10.000714	11.242045	43
18	8.760151	9.999279	8.760872	11.239128	10.000721	11.239849	42
19	8.762337	9.999272	8.763065	11.236935	10.000728	11.237663	41
20	8.764511	9.999265	8.765246	11.234754	10.000735	11.235489	40
21	8.766675	9.999257	8.767418	11.232582	10.000743	11.233325	39
22	8.768827	9.999250	8.769578	11.230422	10.000750	11.231173	38
23	8.770970	9.999242	8.771727	11.228273	10.000758	11.229030	37
24	8.773101	9.999235	8.773866	11.226134	10.000765	11.226899	36
25	8.775223	9.999227	8.775995	11.224005	10.000773	11.224777	35
26	8.777333	9.999220	8.778114	11.221886	10.000780	11.222667	34
27	8.779434	9.999212	8.780222	11.219778	10.000788	11.220566	33
28	8.781524	9.999205	8.782320	11.217680	10.000795	11.218476	32
29	8.783605	9.999197	8.784408	11.215592	10.000803	11.216395	31
30	8.785675	9.999189	8.786486	11.213514	10.000811	11.214325	30
		Sine		Tangent		Secant	Minuets

86 Degrees.

3 Degrees.

Minutes	Sine		Tangent		Secant		
30	8.785675	9.999189	8.786486	11.213514	10.000811	11.214325	30
31	8.787736	9.999181	8.788554	11.211446	10.000819	11.212264	29
32	8.789787	9.999174	8.790613	11.209387	10.000826	11.210213	28
33	8.791828	9.999166	8.792662	11.207338	10.000834	11.208172	27
34	8.793859	9.999158	8.794701	11.205299	10.000842	11.206141	26
35	8.795881	9.999150	8.796731	11.203269	10.000850	11.204119	25
36	8.797894	9.999142	8.798752	11.201248	10.000858	11.202106	24
37	8.799897	9.999134	8.800763	11.199237	10.000866	11.200103	23
38	8.801892	9.999126	8.802765	11.197235	10.000874	11.198108	22
39	8.803876	9.999118	8.804758	11.195242	10.000882	11.196124	21
40	8.805852	9.999110	8.806742	11.193258	10.000890	11.194148	20
41	8.807819	9.999102	8.808717	11.191283	10.000898	11.192181	19
42	8.809777	9.999094	8.810683	11.189317	10.000906	11.190223	18
43	8.811726	9.999086	8.812641	11.187359	10.000914	11.188274	17
44	8.813667	9.999077	8.814589	11.185411	10.000923	11.186333	16
45	8.815598	9.999069	8.816529	11.183471	10.000931	11.184402	15
46	8.817522	9.999061	8.818461	11.181539	10.000939	11.182478	14
47	8.819436	9.999052	8.820384	11.179616	10.000948	11.180564	13
48	8.821343	9.999044	8.822298	11.177702	10.000956	11.178657	12
49	8.823240	9.999036	8.824205	11.175795	10.000964	11.176760	11
50	8.825130	9.999027	8.826103	11.173897	10.000973	11.174870	10
51	8.827011	9.999019	8.827992	11.172008	10.000981	11.172989	9
52	8.828884	9.999010	8.829874	11.170126	10.000990	11.171116	8
53	8.830749	9.999002	8.831748	11.168252	10.000998	11.169251	7
54	8.832607	9.998993	8.833613	11.166387	10.001007	11.167393	6
55	8.834456	9.998984	8.835471	11.164529	10.001016	11.165544	5
56	8.836297	9.998976	8.837321	11.162679	10.001024	11.163703	4
57	8.838130	9.998967	8.839163	11.160837	10.001033	11.161870	3
58	8.839956	9.998958	8.840998	11.159002	10.001042	11.160044	2
59	8.841774	9.998950	8.842825	11.157175	10.001050	11.158226	1
60	8.843584	9.998941	8.844644	11.155356	10.001059	11.156416	0
		Sine		Tangent		Secant	Minutes

86 Degrees.

4 Degrees.

Minutes	Sine		Tangent		Secant		
0	8.843585	9.998941	8.844644	11.155356	10.001059	11.156415	60
1	8.845387	9.998932	8.846455	11.153545	10.001068	11.154613	59
2	8.847183	9.998923	8.848260	11.151740	10.001077	11.152817	58
3	8.848971	9.998914	8.850057	11.149943	10.001086	11.151029	57
4	8.850751	9.998905	8.851846	11.148154	10.001095	11.149249	56
5	8.852524	9.998896	8.853628	11.146372	10.001104	11.147476	55
6	8.854291	9.998887	8.855403	11.144597	10.001113	11.145709	54
7	8.856049	9.998878	8.857171	11.142829	10.001122	11.143951	53
8	8.857801	9.998869	8.858932	11.141068	10.001131	11.142199	52
9	8.859546	9.998860	8.860686	11.139314	10.001140	11.140454	51
10	8.861283	9.998851	8.862433	11.137567	10.001149	11.138717	50
11	8.863014	9.998841	8.864173	11.135827	10.001159	11.136986	49
12	8.864738	9.998832	8.865905	11.134095	10.001168	11.135262	48
13	8.866455	9.998823	8.867632	11.132368	10.001177	11.133545	47
14	8.868165	9.998813	8.869351	11.130649	10.001187	11.131835	46
15	8.869868	9.998804	8.871064	11.128936	10.001196	11.130132	45
16	8.871565	9.998795	8.872770	11.127230	10.001205	11.128435	4
17	8.873255	9.998785	8.874469	11.125531	10.001215	11.126745	43
18	8.874938	9.998776	8.876162	11.123838	10.001224	11.125062	42
19	8.876615	9.998766	8.877849	11.122151	10.001234	11.123385	41
20	8.878285	9.998757	8.879529	11.120471	10.001243	11.121715	40
21	8.879949	9.998747	8.881202	11.118798	10.001253	11.120051	3
22	8.881607	9.998737	8.882869	11.117131	10.001262	11.118393	38
23	8.883258	9.998728	8.884530	11.115470	10.001272	11.116742	37
24	8.884903	9.998718	8.886185	11.113815	10.001282	11.115097	3
25	8.886542	9.998708	8.887833	11.112167	10.001292	11.113458	35
26	8.888174	9.998699	8.889476	11.110524	10.001301	11.111826	34
27	8.889801	9.998689	8.891112	11.108888	10.001311	11.110199	33
28	8.891421	9.998679	8.892742	11.107258	10.001321	11.108579	32
29	8.893035	9.998669	8.894366	11.105634	10.001331	11.106965	31
30	8.894643	9.998659	8.895984	11.104016	10.001341	11.105357	30
		Sine		Tangent		Secant	Minutes

85 Degrees.

4 Degrees.

Minutes	Sine		Tangent		Secant		
30	8.894643	9.998659	8.895984	11.104010	10.001341	11.105357	30
31	8.896245	9.998649	8.897596	11.102404	10.001351	11.103754	29
32	8.897842	9.998639	8.899203	11.100797	10.001361	11.102158	28
33	8.899432	9.998629	8.900803	11.099197	10.001371	11.100568	27
34	8.901017	9.998619	8.902398	11.097602	10.001381	11.098983	26
35	8.902596	9.998609	8.903987	11.096013	10.001391	11.097404	25
36	8.904169	9.998599	8.905570	11.094430	10.001401	11.095831	24
37	8.905736	9.998589	8.907147	11.092853	10.001411	11.094264	23
38	8.907297	9.998578	8.908719	11.091281	10.001422	11.092703	22
39	8.908854	9.998568	8.910285	11.089715	10.001432	11.091146	21
40	8.910404	9.998558	8.911846	11.088154	10.001442	11.089596	20
41	8.911940	9.998548	8.913401	11.086599	10.001452	11.088051	19
42	8.913488	9.998537	8.914951	11.085049	10.001463	11.086512	18
43	8.915022	9.998527	8.916495	11.083505	10.001473	11.084978	17
44	8.916550	9.998516	8.918034	11.081966	10.001484	11.083450	16
45	8.918073	9.998506	8.919567	11.080432	10.001494	11.081927	15
46	8.919591	9.998495	8.921096	11.078904	10.001505	11.080409	14
47	8.921103	9.998485	8.922619	11.077381	10.001515	11.078897	13
48	8.922611	9.998474	8.924136	11.075864	10.001526	11.077389	12
49	8.924112	9.998464	8.925649	11.074351	10.001536	11.075888	11
50	8.925609	9.998453	8.927156	11.072844	10.001547	11.074391	10
51	8.927100	9.998442	8.928658	11.071342	10.001558	11.072900	9
52	8.928587	9.998431	8.930155	11.069845	10.001569	11.071413	8
53	8.930068	9.998421	8.931647	11.068353	10.001579	11.069932	7
54	8.931544	9.998410	8.933134	11.066866	10.001590	11.068456	6
55	8.933015	9.998399	8.934616	11.065384	10.001601	11.066985	5
56	8.934481	9.998388	8.936093	11.063907	10.001612	11.065519	4
57	8.935942	9.998377	8.937565	11.062435	10.001623	11.064058	3
58	8.937398	9.998366	8.939032	11.060968	10.001634	11.062602	2
59	8.938850	9.998355	8.940494	11.059506	10.001645	11.061150	1
60	8.940296	9.998344	8.941952	11.058048	10.001656	11.059704	0
		Sine		Tangent		Secant	Minutes

85 Degrees.

5 Degrees.

Minutes	Sine		Tangent		Secant		
0	8.940296	9.998344	8.941952	11.058048	10.001656	11.059704	60
1	8.941738	9.998333	8.943404	11.056596	10.001667	11.058262	59
2	8.943174	9.998322	8.944852	11.055148	10.001678	11.056826	58
3	8.944606	9.998311	8.946295	11.053705	10.001689	11.055394	57
4	8.946034	9.998300	8.947734	11.052266	10.001700	11.053966	56
5	8.947456	9.998289	8.949168	11.050832	10.001711	11.052544	55
6	8.948874	9.998277	8.950597	11.049403	10.001723	11.051126	54
7	8.950287	9.998266	8.952021	11.047979	10.001734	11.049713	53
8	8.951696	9.998255	8.953441	11.046559	10.001745	11.048304	52
9	8.953100	9.998243	8.954856	11.045144	10.001757	11.046900	51
10	8.954499	9.998232	8.956267	11.043733	10.001768	11.045501	50
11	8.955894	9.998220	8.957673	11.042327	10.001780	11.044106	49
12	8.957284	9.998209	8.959075	11.040925	10.001791	11.042716	48
13	8.958670	9.998197	8.960473	11.039527	10.001803	11.041330	47
14	8.960052	9.998186	8.961866	11.038134	10.001814	11.039948	46
15	8.961429	9.998174	8.963254	11.036746	10.001826	11.038571	45
16	8.962801	9.998163	8.964639	11.035361	10.001837	11.037199	44
17	8.964170	9.998151	8.966019	11.033981	10.001849	11.035830	43
18	8.965534	9.998139	8.967394	11.032606	10.001861	11.034466	42
19	8.966893	9.998127	8.968766	11.031234	10.001873	11.033107	41
20	8.968249	9.998116	8.970133	11.029867	10.001884	11.031751	40
21	8.969600	9.998104	8.971496	11.028504	10.001896	11.030400	39
22	8.970947	9.998092	8.972855	11.027145	10.001908	11.029053	38
23	8.972289	9.998080	8.974209	11.025791	10.001920	11.027711	37
24	8.973628	9.998068	8.975560	11.024440	10.001932	11.026372	36
25	8.974962	9.998056	8.976906	11.023094	10.001944	11.025038	35
26	8.976293	9.998044	8.978248	11.021752	10.001956	11.023707	34
27	8.977619	9.998032	8.979586	11.020414	10.001968	11.022381	33
28	8.978941	9.998020	8.980921	11.019079	10.001980	11.021059	32
29	8.980259	9.998008	8.982251	11.017749	10.001992	11.019741	31
30	8.981573	9.997996	8.983577	11.016423	10.002004	11.018427	30
		Sine		Tangent		Secant	Minutes

84 Degrees.

5 Degrees.

Sine		Tangent		Secant		
8.981573	9.997996	8.983577	11.016423	10.002004	11.018427	30
8.982883	9.997984	8.984899	11.015101	10.002016	11.017117	29
8.984189	9.997972	8.986217	11.013783	10.002028	11.015811	28
8.985491	9.997959	8.987532	11.012468	10.002041	11.014509	27
8.986789	9.997947	8.988842	11.011158	10.002053	11.013211	26
8.988083	9.997935	8.990149	11.009851	10.002065	11.011917	25
8.989374	9.997922	8.991451	11.008549	10.002078	11.010626	24
8.990660	9.997910	8.992750	11.007250	10.002090	11.009340	23
8.991943	9.997897	8.994045	11.005955	10.002103	11.008057	22
8.993222	9.997885	8.995337	11.004663	10.002115	11.006778	21
8.994497	9.997873	8.996624	11.003376	10.002127	11.005503	20
8.995768	9.997859	8.997908	11.002092	10.002141	11.004232	19
8.997036	9.997847	8.999188	11.000812	10.002153	11.002964	18
8.998299	9.997835	9.000465	10.999535	10.002165	11.001701	17
8.999559	9.997822	9.001738	10.998262	10.002178	11.000441	16
9.000816	9.997809	9.003007	10.996993	10.002191	10.999184	15
9.002069	9.997797	9.004272	10.995728	10.002203	10.997931	14
9.003318	9.997784	9.005534	10.994466	10.002216	10.996682	13
9.004563	9.997771	9.006792	10.993208	10.002229	10.995437	12
9.005805	9.997758	9.008047	10.991953	10.002242	10.994195	11
9.007044	9.997745	9.009298	10.990702	10.002255	10.992956	10
9.008278	9.997732	9.010546	10.989454	10.002268	10.991722	9
9.009510	9.997719	9.011790	10.988210	10.002281	10.990490	8
9.010737	9.997706	9.013031	10.986969	10.002294	10.989263	7
9.011962	9.997693	9.014268	10.985732	10.002307	10.988038	6
9.013182	9.997680	9.015502	10.984498	10.002320	10.986818	5
9.014400	9.997667	9.016733	10.983267	10.002333	10.985600	4
9.015613	9.997654	9.017959	10.982041	10.002346	10.984387	3
9.016824	9.997641	9.019183	10.980817	10.002359	10.983176	2
9.018031	9.997628	9.020403	10.979597	10.002372	10.981969	1
9.019235	9.997614	9.021620	10.978380	10.002386	10.980765	0
	Sine		Tangent		Secant	Minutes

84 Degrees.

6 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.019235	9.997614	9.021620	10.978380	10.002386	10.980765	6
1	9.020435	9.997601	9.022834	10.977166	10.002399	10.979565	5
2	9.021632	9.997588	9.024044	10.975956	10.002412	10.978368	5
3	9.022825	9.997574	9.025251	10.974749	10.002426	10.977175	5
4	9.024016	9.997561	9.026455	10.973545	10.002439	10.975984	5
5	9.025203	9.997547	9.027655	10.972345	10.002453	10.974797	5
6	9.026386	9.997534	9.028852	10.971148	10.002466	10.973614	5
7	9.027567	9.997521	9.030046	10.969954	10.002479	10.972433	5
8	9.028744	9.997507	9.031237	10.968763	10.002493	10.971256	5
9	9.029918	9.997493	9.032425	10.967575	10.002507	10.970082	5
10	9.031089	9.997480	9.033609	10.966391	10.002520	10.968911	5
11	9.032257	9.997466	9.034791	10.965209	10.002534	10.967743	4
12	9.033421	9.997452	9.035969	10.964031	10.002548	10.966579	4
13	9.034582	9.997439	9.037144	10.962856	10.002561	10.965418	4
14	9.035741	9.997425	9.038316	10.961684	10.002575	10.964259	4
15	9.036896	9.997411	9.039485	10.960515	10.002589	10.963104	4
16	9.038048	9.997397	9.040651	10.959349	10.002603	10.961952	4
17	9.039197	9.997383	9.041813	10.958187	10.002617	10.960803	4
18	9.040342	9.997369	9.042973	10.957027	10.002631	10.959658	4
19	9.041485	9.997355	9.044130	10.955870	10.002645	10.958515	4
20	9.042625	9.997341	9.045284	10.954716	10.002659	10.957375	4
21	9.043762	9.997327	9.046434	10.953566	10.002673	10.956238	3
22	9.044895	9.997313	9.047582	10.952418	10.002687	10.955105	3
23	9.046026	9.997299	9.048727	10.951273	10.002701	10.953974	3
24	9.047154	9.997285	9.049869	10.950131	10.002715	10.952846	3
25	9.048279	9.997271	9.051008	10.948992	10.002729	10.951721	3
26	9.049400	9.997257	9.052144	10.947856	10.002743	10.950600	3
27	9.050519	9.997242	9.053277	10.946723	10.002758	10.949481	3
28	9.051635	9.997228	9.054407	10.945593	10.002772	10.948365	3
29	9.052748	9.997214	9.055535	10.944465	10.002786	10.947252	3
30	9.053859	9.997199	9.056659	10.943341	10.002801	10.946141	3
		Sine		Tangent		Secant	Minutes

83 Degrees.

6 Degrees.

Sine		Tangent		Secant		
9.053859	9.997199	9.056659	10.943341	10.002801	10.946141	30
9.054966	9.997185	9.057781	10.942219	10.002815	10.945034	29
9.056071	9.997170	9.058900	10.941100	10.002830	10.943929	28
9.057172	9.997156	9.060016	10.939984	10.002844	10.942828	27
9.058271	9.997141	9.061130	10.938870	10.002859	10.941729	26
9.059367	9.997127	9.062240	10.937760	10.002873	10.940633	25
9.060460	9.997112	9.063348	10.936652	10.002888	10.939540	24
9.061551	9.997098	9.064453	10.935547	10.002902	10.938449	23
9.062639	9.997083	9.065556	10.934444	10.002917	10.937361	22
9.063723	9.997068	9.066655	10.933345	10.002932	10.936277	21
9.064806	9.997053	9.067752	10.932248	10.002947	10.935194	20
9.065885	9.997039	9.068846	10.931154	10.002961	10.934115	19
9.066962	9.997024	9.069938	10.930062	10.002976	10.933038	18
9.068036	9.997009	9.071027	10.928973	10.002991	10.931964	17
9.069107	9.996994	9.072113	10.927887	10.003006	10.930893	16
9.070176	9.996979	9.073197	10.926803	10.003021	10.929824	15
9.071242	9.996964	9.074278	10.925722	10.003036	10.928758	14
9.072305	9.996949	9.075356	10.924644	10.003051	10.927695	13
9.073366	9.996934	9.076432	10.923568	10.003066	10.926634	12
9.074424	9.996919	9.077505	10.922495	10.003081	10.925576	11
9.075480	9.996904	9.078576	10.921424	10.003096	10.924520	10
9.076533	9.996889	9.079644	10.920356	10.003111	10.923467	9
9.077583	9.996874	9.080710	10.919290	10.003126	10.922417	8
9.078631	9.996858	9.081773	10.918227	10.003142	10.921369	7
9.079676	9.996843	9.082833	10.917167	10.003157	10.920324	6
9.080719	9.996828	9.083891	10.916109	10.003172	10.919281	5
9.081759	9.996812	9.084947	10.915053	10.003188	10.918241	4
9.082797	9.996797	9.086000	10.914000	10.003203	10.917203	3
9.083832	9.996782	9.087050	10.912950	10.003218	10.916168	2
9.084864	9.996766	9.088098	10.911902	10.003234	10.915136	1
9.085894	9.996751	9.089144	10.910856	10.003249	10.914106	0
	Sine		Tangent		Secant	Minute.

83 Degrees.

A Table of Artificial Sines,

7 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.085895	9.996751	9.089144	10.910856	10.003249	10.914105	
1	9.086922	9.996735	9.090187	10.909813	10.003265	10.913078	
2	9.087947	9.996720	9.091228	10.908772	10.003280	10.912053	
3	9.088970	9.996704	9.092266	10.907734	10.003296	10.911030	
4	9.089990	9.996688	9.093302	10.906698	10.003312	10.910010	
5	9.091008	9.996673	9.094335	10.905665	10.003327	10.908992	
6	9.092024	9.996657	9.095367	10.904633	10.003343	10.907976	
7	9.093037	9.996641	9.096395	10.903605	10.003359	10.906963	
8	9.094047	9.996625	9.097422	10.902578	10.003375	10.905953	
9	9.095056	9.996610	9.098446	10.901554	10.003390	10.904944	
10	9.096062	9.996594	9.099468	10.900532	10.003406	10.903938	
11	9.097065	9.996578	9.100487	10.899513	10.003422	10.902935	
12	9.098066	9.996562	9.101504	10.898496	10.003438	10.901934	
13	9.099065	9.996546	9.102519	10.897481	10.003454	10.900935	
14	9.100062	9.996530	9.103532	10.896468	10.003470	10.899938	
15	9.101056	9.996514	9.104542	10.895458	10.003486	10.898944	
16	9.102048	9.996498	9.105550	10.894450	10.003502	10.897952	
17	9.103037	9.996482	9.106556	10.893444	10.003518	10.896963	
18	9.104025	9.996465	9.107559	10.892441	10.003535	10.895975	
19	9.105010	9.996449	9.108560	10.891440	10.003551	10.894990	
20	9.105992	9.996433	9.109559	10.890441	10.003567	10.894008	
21	9.106973	9.996417	9.110556	10.889444	10.003583	10.893027	
22	9.107951	9.996400	9.111551	10.888449	10.003600	10.892049	
23	9.108927	9.996384	9.112543	10.887457	10.003616	10.891073	
24	9.109901	9.996368	9.113533	10.886467	10.003632	10.890099	
25	9.110873	9.996351	9.114521	10.885479	10.003649	10.889127	
26	9.111842	9.996335	9.115507	10.884493	10.003665	10.888158	
27	9.112809	9.996318	9.116491	10.883509	10.003682	10.887191	
28	9.113774	9.996302	9.117472	10.882528	10.003698	10.886226	
29	9.114737	9.996285	9.118452	10.881548	10.003715	10.885263	
30	9.115698	9.996269	9.119429	10.880571	10.003731	10.884302	
		Sine		Tangent		Secant	Minutes

82 Degrees.

7 Degrees.

Sine		Tangent		Secant		
9.115698	9.996269	9.119429	10.880571	10.003731	10.884302	30
9.116656	9.996252	9.120404	10.879596	10.003748	10.883344	29
9.117612	9.996235	9.121377	10.878623	10.003765	10.882388	28
9.118567	9.996218	9.122348	10.877652	10.003782	10.881433	27
9.119519	9.996202	9.123317	10.876683	10.003798	10.880481	26
9.120469	9.996185	9.124284	10.875716	10.003815	10.879531	25
9.121417	9.996168	9.125249	10.874751	10.003832	10.878583	24
9.122362	9.996151	9.126211	10.873789	10.003849	10.877638	23
9.123306	9.996134	9.127172	10.872828	10.003866	10.876694	22
9.124248	9.996117	9.128130	10.871870	10.003883	10.875752	21
9.125187	9.996100	9.129087	10.870913	10.003900	10.874813	20
9.126125	9.996083	9.130041	10.869959	10.003917	10.873875	19
9.127060	9.996066	9.130994	10.869006	10.003934	10.872940	18
9.127993	9.996049	9.131944	10.868056	10.003951	10.877007	17
9.128925	9.996032	9.132893	10.867107	10.003968	10.871075	16
9.129854	9.996015	9.133839	10.866161	10.003985	10.870146	15
9.130781	9.995998	9.134783	10.865217	10.004002	10.869219	14
9.131706	9.995980	9.135726	10.864274	10.004020	10.868294	13
9.132630	9.995963	9.136666	10.863334	10.004037	10.867370	12
9.133551	9.995946	9.137605	10.862395	10.004054	10.866449	11
9.134470	9.995928	9.138542	10.861458	10.004072	10.865530	10
9.135387	9.995911	9.139476	10.860524	10.004089	10.864613	9
9.136303	9.995894	9.140409	10.859591	10.004106	10.863697	8
9.137216	9.995876	9.141340	10.858660	10.004124	10.862784	7
9.138127	9.995859	9.142269	10.857731	10.004141	10.861873	6
9.139037	9.995841	9.143196	10.856804	10.004159	10.860963	5
9.139944	9.995823	9.144121	10.855879	10.004177	10.860056	4
9.140850	9.995806	9.145044	10.854956	10.004194	10.859150	3
9.141754	9.995788	9.145965	10.854035	10.004212	10.858245	2
9.142655	9.995770	9.146885	10.853115	10.004230	10.857345	1
9.143555	9.995753	9.147802	10.852198	10.004247	10.856445	0
	Sine		Tangent		Secant	Minutes

82 Degrees.

8 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.143555	9.995753	9.147802	10.852198	10.004247	10.856445	60
1	9.144453	9.995735	9.148718	10.851282	10.004265	10.855547	59
2	9.145349	9.995717	9.149632	10.850368	10.004283	10.854651	58
3	9.146243	9.995699	9.150544	10.849456	10.004301	10.853757	57
4	9.147136	9.995681	9.151454	10.848546	10.004319	10.852864	56
5	9.148026	9.995663	9.152363	10.847637	10.004337	10.851974	55
6	9.148915	9.995646	9.153269	10.846731	10.004354	10.851085	54
7	9.149801	9.995628	9.154174	10.845826	10.004372	10.850199	53
8	9.150686	9.995609	9.155077	10.844923	10.004391	10.849314	52
9	9.151569	9.995591	9.155978	10.844022	10.004409	10.848431	51
10	9.152451	9.995573	9.156877	10.843123	10.004427	10.847549	50
11	9.153330	9.995555	9.157775	10.842225	10.004445	10.846670	49
12	9.154208	9.995537	9.158671	10.841329	10.004463	10.845792	48
13	9.155083	9.995519	9.159565	10.840435	10.004481	10.844917	47
14	9.155957	9.995500	9.160457	10.839543	10.004500	10.844043	46
15	9.156830	9.995482	9.161347	10.838653	10.004518	10.843170	45
16	9.157700	9.995464	9.162236	10.837764	10.004536	10.842300	44
17	9.158569	9.995445	9.163123	10.836877	10.004355	10.841431	43
18	9.159435	9.995427	9.164008	10.835992	10.004573	10.840565	42
19	9.160300	9.995409	9.164892	10.835108	10.004591	10.839700	41
20	9.161164	9.995390	9.165774	10.834226	10.004610	10.838836	40
21	9.162025	9.995372	9.166654	10.833346	10.004628	10.837975	39
22	9.162885	9.995353	9.167532	10.832468	10.004647	10.837115	38
23	9.163743	9.995334	9.168409	10.831591	10.004666	10.836257	37
24	9.164600	9.995316	9.169284	10.830716	10.004684	10.835400	36
25	9.165454	9.995297	9.170157	10.829843	10.004703	10.834546	35
26	9.166307	9.995278	9.171029	10.828971	10.004722	10.833693	34
27	9.167159	9.995260	9.171899	10.828101	10.004740	10.832841	33
28	9.168008	9.995241	9.172767	10.827233	10.004759	10.831992	32
29	9.168856	9.995222	9.173634	10.826366	10.004778	10.831144	31
30	9.169702	9.995203	9.174499	10.825501	10.004797	10.830298	30
		Sine		Tangent		Secant	Minutes

81 Degrees.

8 Degrees.

Sine		Tangent		Secant		
9.169702	9.995203	9.174499	10.825501	10.004797	10.830298	30
9.170546	9.995184	9.175362	10.824638	10.004816	10.829454	29
9.171389	9.995165	9.176224	10.823776	10.004835	10.828611	28
9.172230	9.995146	9.177084	10.822916	10.004854	10.827770	27
9.173070	9.995127	9.177942	10.822058	10.004873	10.826930	26
9.173908	9.995108	9.178799	10.821201	10.004892	10.826092	25
9.174744	9.995089	9.179655	10.820345	10.004911	10.825256	24
9.175578	9.995070	9.180508	10.819492	10.004930	10.824422	23
9.176411	9.995051	9.181360	10.818640	10.004949	10.823589	22
9.177242	9.995032	9.182211	10.817789	10.004968	10.822758	21
9.178072	9.995013	9.183059	10.816941	10.004987	10.821928	20
9.178900	9.994993	9.183907	10.816093	10.005007	10.821100	19
9.179726	9.994974	9.184752	10.815248	10.005026	10.820274	18
9.180551	9.994955	9.185597	10.814403	10.005045	10.819449	17
9.181374	9.994935	9.186439	10.813561	10.005065	10.818626	16
9.182196	9.994916	9.187280	10.812720	10.005084	10.817804	15
9.183016	9.994896	9.188120	10.811880	10.005104	10.816984	14
9.183834	9.994877	9.188957	10.811043	10.005123	10.816166	13
9.184651	9.994857	9.189794	10.810206	10.005143	10.815349	12
9.185466	9.994838	9.190629	10.809371	10.005162	10.814534	11
9.186280	9.994818	9.191462	10.808538	10.005182	10.813720	10
9.187092	9.994798	9.192294	10.807706	10.005202	10.812908	9
9.187903	9.994779	9.193124	10.806876	10.005221	10.812097	8
9.188712	9.994759	9.193953	10.806047	10.005241	10.811288	7
9.189519	9.994739	9.194780	10.805220	10.005261	10.810481	6
9.190325	9.994719	9.195606	10.804394	10.005281	10.809675	5
9.191130	9.994700	9.196430	10.803570	10.005300	10.808870	4
9.191933	9.994680	9.197253	10.802747	10.005320	10.808067	3
9.192734	9.994660	9.198074	10.801926	10.005340	10.807266	2
9.193534	9.994640	9.198894	10.801106	10.005360	10.806466	1
9.194332	9.994620	9.199712	10.800288	10.005380	10.805668	0
	Sine		Tangent		Secant	Minutes

81 Degrees.

9 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.194332	9.994620	9.199712	10.800288	10.005380	10.805668	6
1	9.195129	9.994600	9.200529	10.799471	10.005400	10.804871	5
2	9.195925	9.994580	9.201345	10.798655	10.005420	10.804075	5
3	9.196719	9.994560	9.202159	10.747841	10.005440	10.803281	5
4	9.197511	9.994540	9.202971	10.797029	10.005460	10.802489	5
5	9.198302	9.994519	9.203782	10.796218	10.005481	10.801698	5
6	9.199091	9.994499	9.204592	10.795408	10.005501	10.800909	54
7	9.199879	9.994479	9.205400	10.794600	10,005521	10.800121	5
8	9.200666	9.994459	9.206207	10.793793	10.005541	10.799334	5
9	9.201451	9.994438	9.207013	10.792987	10.005562	10.798549	5
10	9.202234	9.994418	9.207817	10.792183	10.005582	10.797766	5
11	9.203017	9.994397	9.208619	10.791381	10.005603	10.796983	49
12	9.203797	9.994377	9.209420	10.790580	10.005623	10.796203	48
13	9.204577	9.994357	9.210220	10.789780	10.005643	10.795423	47
14	9.205354	9.994336	9.211018	10.788982	10.005664	10.794646	46
15	9.206131	9.994316	9.211815	10.788185	10.005684	10.793869	45
16	9.206906	9.994295	9.212611	10.787389	10.005705	10.793094	44
17	9.207679	9.994274	9.213405	10.786595	10.005726	10.792321	43
18	9.208452	9.994254	9.214198	10.785802	10,005746	10.791548	42
19	9.209222	9.994233	9.214989	10.785011	10.005767	10.790778	41
20	9.209992	9.994212	9.215779	10.784221	10.005788	10.790008	40
21	9.210760	9.994191	9.216568	10.783432	10.005809	10.789240	39
22	9.211526	9.994171	9.217356	10.782644	10.005829	10.788474	38
23	9.212291	9.994150	9.218142	10.781858	10.005850	10.787709	37
24	9.213055	9.994129	9.218926	10.781074	10.005871	10.786945	36
25	9.213818	9.994108	9.219710	10.780290	10.005892	10.786182	35
26	9.214579	9.994087	9.220492	10.779508	10.005913	10.785421	34
27	9.215338	9.994066	9.221272	10.778728	10.005934	10.784662	33
28	9.216097	9.994045	9.222052	10.777948	10.005955	10.783903	32
29	9.216854	9.994024	9.222830	10.777170	10.005976	10.783146	31
30	9.217609	9.994003	9.223606	10.776394	10.005997	10.782391	30
		Sine		Tangent		Secant	Minutes

80 Degrees.

9 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.217609	9.994003	9.223606	10.776394	10.005997	10.782391	30
31	9.218363	9.993981	9.224382	10.775618	10.006019	10.781637	29
32	9.219116	9.993960	9.225156	10.774844	10.006040	10.780884	28
33	9.219868	9.993939	9.225929	10.774071	10.006061	10.780132	27
34	9.220618	9.993918	9.226700	10.773300	10.006082	10.779382	26
35	9.221367	9.993896	9.227471	10.772529	10.006104	10.778633	25
36	9.222115	9.993875	9.228239	10.771761	10.006125	10.777885	24
37	9.222861	9.993854	9.229007	10.770993	10.006146	10.777139	23
38	9.223606	9.993832	9.229774	10.770226	10.006168	10.776394	22
39	9.224349	9.993811	9.230539	10.769461	10.006189	10.775651	21
40	9.225092	9.993789	9.231302	10.768698	10.006211	10.774908	20
41	9.225833	9.993768	9.232065	10.767935	10.006232	10.774167	19
42	9.226573	9.993746	9.232826	10.767174	10.006254	10.773427	18
43	9.227311	9.993725	9.233586	10.766414	10.006275	10.772689	17
44	9.228048	9.993703	9.234345	10.765655	10.006297	10.771952	16
45	9.228784	9.993681	9.235103	10.764897	10.006319	10.771216	15
46	9.229519	9.993660	9.235859	10.764141	10.006340	10.770481	14
47	9.230252	9.993638	9.236614	10.763386	10.006362	10.769748	13
48	9.230984	9.993616	9.237368	10.762632	10.006384	10.769016	12
49	9.231715	9.993594	9.238120	10.761880	10.006406	10.768285	11
50	9.232444	9.993572	9.238872	10.761128	10.006428	10.767556	10
51	9.233172	9.993550	9.239622	10.760378	10.006450	10.766828	9
52	9.233899	9.993528	9.240371	10.759629	10.006472	10.766101	8
53	9.234625	9.993507	9.241118	10.758882	10.006493	10.765375	7
54	9.235349	9.993484	9.241865	10.758135	10.006516	10.764651	6
55	9.236073	9.993462	9.242610	10.757390	10.006538	10.763927	5
56	9.236795	9.993440	9.243354	10.756646	10.006560	10.763205	4
57	9.237515	9.993418	9.244097	10.755903	10.006582	10.762485	3
58	9.238235	9.993396	9.244839	10.755161	10.006604	10.761765	2
59	9.238953	9.993374	9.245579	10.754421	10.006626	10.761047	1
60	9.239670	9.993352	9.246319	10.753681	10.006648	10.760330	0
		Sine		Tangent		Secant	Minutes

80 Degrees.

10 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.239670	9.993351	9.246319	10.753681	10.006649	10.760330	60
1	9.240386	9.993329	9.247057	10.752943	10.006671	10.759614	59
2	9.241101	9.993307	9.247794	10.752206	10.006693	10.758899	58
3	9.241814	9.993284	9.248530	10.751470	10.006716	10.758186	57
4	9.242526	9.993262	9.249264	10.750736	10.006738	10.757474	56
5	9.243237	9.993240	9.249998	10.750002	10.006760	10.756763	55
6	9.243947	9.993217	9.250730	10.749270	10.006783	10.756053	54
7	9.244656	9.993195	9.251461	10.748539	10.006805	10.755344	53
8	9.245363	9.993172	9.252191	10.747809	10.006828	10.754637	52
9	9.246069	9.993149	9.252920	10.747080	10.006851	10.753931	51
10	9.246775	9.993127	9.253648	10.746352	10.006873	10.753225	50
11	9.247478	9.993104	9.254374	10.745626	10.006896	10.752522	49
12	9.248181	9.993081	9.255100	10.744900	10.006919	10.751819	48
13	9.248883	9.993059	9.255824	10.744176	10.006941	10.751117	47
14	9.249583	9.993036	9.256547	10.743453	10.006964	10.750417	46
15	9.250282	9.993013	9.257269	10.742731	10.006987	10.749718	45
16	9.250980	9.992990	9.257990	10.742010	10.007010	10.749020	44
17	9.251677	9.992967	9.258710	10.741290	10.007033	10.748323	43
18	9.252373	9.992944	9.259428	10.740572	10.007056	10.747627	42
19	9.253067	9.992921	9.260146	10.739854	10.007079	10.746933	41
20	9.253761	9.992898	9.260862	10.739138	10.007102	10.746239	40
21	9.254453	9.992875	9.261578	10.738422	10.007125	10.745547	39
22	9.255144	9.992852	9.262292	10.737708	10.007148	10.744856	38
23	9.255834	9.992829	9.263005	10.736995	10.007171	10.744166	37
24	9.256523	9.992806	9.263717	10.736283	10.007194	10.743477	36
25	9.257211	9.992783	9.264428	10.735572	10.007217	10.742789	35
26	9.257898	9.992759	9.265138	10.734862	10.007241	10.742102	34
27	9.258583	9.992736	9.265847	10.734153	10.007264	10.741417	33
28	9.259268	9.992713	9.266555	10.733445	10.007287	10.740732	32
29	9.259951	9.992689	9.267261	10.732739	10.007311	10.740049	31
30	9.260633	9.992666	9.267967	10.732033	10.007334	10.739367	30
		Sine		Tangent		Secant	Minutes

79 Degrees.

10 Degrees.

Minutes	Sine		Tangent		Secant		
30	9·260633	9·992666	9·267967	10·732033	10·007334	10·739367	30
31	9·261314	9·992643	9·268671	10·731329	10·007357	10·738686	29
32	9·261994	9·992619	9·269375	10·730625	10·007381	10·738006	28
33	9·262673	9·992596	9·270077	10·729923	10·007404	10·737327	27
34	9·263351	9·992572	9·270779	10·729221	10·007428	10·736649	26
35	9·264026	9·992549	9·271479	10·728521	10·007451	10·735973	25
36	9·264703	9·992525	9·272178	10·727822	10·007475	10·735297	24
37	9·265377	9·992501	9·272876	10·727124	10·007499	10·734623	23
38	9·266051	9·992478	9·273573	10·726427	10·007522	10·733949	22
39	9·266723	9·992454	9·274269	10·725731	10·007546	10·733277	21
40	9·267395	9·992430	9·274964	10·725036	10·007570	10·732605	20
41	9·268065	9·992406	9·275658	10·724342	10·007594	10·731935	19
42	9·268734	9·992382	9·276351	10·723649	10·007618	10·731266	18
43	9·269402	9·992358	9·277043	10·722957	10·007642	10·730598	17
44	9·270069	9·992335	9·277734	10·722266	10·007665	10·729931	16
45	9·270735	9·992311	9·278424	10·721576	10·007689	10·729265	15
46	9·271400	9·992287	9·279113	10·720887	10·007713	10·728600	14
47	9·272063	9·992263	9·279801	10·720199	10·007737	10·727937	13
48	9·272726	9·992238	9·280488	10·719512	10·007762	10·727274	12
49	9·273388	9·992214	9·281174	10·718826	10·007786	10·726612	11
50	9·274049	9·992190	9·281858	10·718142	10·007810	10·725951	10
51	9·274708	9·992166	9·282542	10·717458	10·007834	10·725292	9
52	9·275367	9·992142	9·283225	10·716775	10·007858	10·724633	8
53	9·276024	9·992117	9·283907	10·716093	10·007883	10·723976	7
54	9·276681	9·992093	9·284588	10·715412	10·007907	10·723319	6
55	9·277337	9·992069	9·285268	10·714732	10·007931	10·722663	5
56	9·277991	9·992044	9·285947	10·714053	10·007956	10·722009	4
57	9·278644	9·992020	9·286624	10·713376	10·007980	10·721356	3
58	9·279297	9·991996	9·287301	10·712699	10·008004	10·720703	2
59	9·279948	9·991971	9·287977	10·712023	10·008029	10·720052	1
60	9·280599	9·991947	9·288652	10·711348	10·008053	10·719401	0
		Sine		Tangent		Secant	Minutes

79 Degrees.

11 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.280599	9.991947	9.288652	10.711348	10.008053	10.719401	60
1	9.281248	9.991922	9.289326	10.710674	10.008078	10.718752	59
2	9.281897	9.991897	9.289999	10.710001	10.008103	10.718103	58
3	9.282544	9.991873	9.290671	10.709329	10.008127	10.717456	57
4	9.283190	9.991848	9.291342	10.708658	10.008152	10.716810	56
5	9.283836	9.991823	9.292013	10.707987	10.008177	10.716164	55
6	9.284480	9.991799	9.292682	10.707318	10.008201	10.715520	54
7	9.285124	9.991774	9.293350	10.706650	10.008226	10.714876	53
8	9.285766	9.991749	9.294017	10.705983	10.008251	10 714234	52
9	9.286408	9.991724	9.294684	10.705316	10.008276	10.713592	51
10	9.287048	9.991699	9.295349	10.704651	10.008301	10.712952	50
11	9.287687	9.991674	9.296013	10.703987	10.008326	10.712313	49
12	9.288326	9.991649	9.296677	10.703323	10.008351	10.711674	48
13	9.288964	9.991624	9.297339	10.702661	10.008376	10.711036	47
14	9.289600	9.991599	9.298001	10.701999	10.008401	10.710400	46
15	9.290236	9.991574	9.298662	10.701338	10.008426	10.709764	45
16	9.290870	9.991549	9.299322	10.700678	10.008451	10.709130	44
17	9.291504	9.991524	9.299980	10.700020	10.008476	10.708496	43
18	9.292137	9.991498	9.300638	10.699362	10.008502	10.707863	42
19	9.292768	9.991473	9.301295	10.698705	10.008527	10.707232	41
20	9.293399	9.991448	9.301951	10.698049	10.008552	10.706601	40
21	9.294029	9.991423	9.302607	10.697393	10.008577	10.705971	39
22	9.294658	9.991397	9.303261	10.696739	10.008603	10.705342	38
23	9.295286	9.991372	9.303914	10.696086	10.008628	10.704714	37
24	9.295913	9.991346	9.304567	10.695433	10.008654	10.704087	36
25	9.296539	9.991321	9.305218	10.694782	10.008679	10.703461	35
26	9.297164	9.991295	9.305869	10.694131	10.008705	10.702836	34
27	9.297788	9.991270	9.306519	10.693481	10.008730	10.702212	33
28	9.298412	9.991244	9.307167	10.692833	10.008756	10.701588	32
29	9.299034	9.991218	9.307815	10.692185	10.008782	10.700966	31
30	9.299655	9.991193	9.308463	10.691537	10.008807	10.700345	30
		Sine		Tangent		Secant	Minntes

78 Degrees.

11 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.299655	9.991193	9.308463	10.691537	10.008807	10.700345	30
31	9.300276	9.991167	9.309109	10.690891	10.008833	10.699724	29
32	9.300895	9.991141	9.309754	10.690246	10.008859	10.699105	28
33	9.301514	9.991115	9.310398	10.689602	10.008885	10.698486	27
34	9.302132	9.991090	9.311042	10.688958	10.008910	10.697868	26
35	9.302749	9.991064	9.311685	10.688315	10.008936	10.697251	25
36	9.303364	9.991038	9.312327	10.687673	10.008962	10.696636	24
37	9.303979	9.991012	9.312967	10.687033	10.008988	10.696021	23
38	9.304593	9.990986	9.313608	10.686392	10.009014	10.695407	22
39	9.305207	9.990960	9.314247	10.685753	10.009040	10.694793	21
40	9.305819	9.990934	9.314885	10.685115	10.009066	10.694181	20
41	9.306430	9.990908	9.315523	10.684477	10.009092	10.693570	19
42	9.307041	9.990882	9.316159	10.683841	10.009118	10.692959	18
43	9.307650	9.990855	9.316795	10.683205	10.009145	10.692350	17
44	9.308259	9.990829	9.317430	10.682570	10.009171	10.691741	16
45	9.308867	9.990803	9.318064	10.681936	10.009197	10.691133	15
46	9.309474	9.990777	9.318697	10.681303	10.009223	10.690520	14
47	9.310080	9.990750	9.319329	10.680671	10.009250	10.689920	13
48	9.310685	9.990724	9.319961	10.680039	10.009276	10.689315	12
49	9.311289	9.990697	9.320592	10.679408	10.009303	10.688711	11
50	9.311893	9.990671	9.321222	10.678778	10.009329	10.688107	10
51	9.312495	9.990644	9.321851	10.678149	10.009356	10.687505	9
52	9.313097	9.990618	9.322479	10.677521	10.009382	10.686903	8
53	9.313698	9.990591	9.323106	10.676894	10.009409	10.686302	7
54	9.314297	9.990565	9.323733	10.676267	10.009435	10.685703	6
55	9.314896	9.990538	9.324358	10.675642	10.009462	10.685104	5
56	9.315495	9.990511	9.324983	10.675017	10.009489	10.684505	4
57	9.316092	9.990485	9.325607	10.674393	10.009515	10.683908	3
58	9.316688	9.990458	9.326230	10.673770	10.009542	10.683312	2
59	9.317284	9.990431	9.326853	10.673147	10.009569	10.682716	1
60	9.317879	9.990404	9.327474	10.672526	10.009596	10.682121	0
		Sine		Tangent		Secant	Minutes

78 Degrees.

A Table of Artificial Sines,

12 Degrees.

Minutes	Sine		Tangent		Secant		
0	9·317879	9·990404	9·327474	10.672526	10.009596	10.682121	60
1	9·318473	9·990377	9·328095	10.671905	10.009623	10.681527	59
2	9·319066	9·990351	9·328715	10.671285	10.009649	10.680934	58
3	9·319658	9·990324	9·329334	10.670666	10.009676	10.680342	57
4	9·320249	9·990297	9·329953	10.670047	10.009703	10.679751	56
5	9·320840	9·990270	9·330570	10.669430	10.009730	10.679160	55
6	9·321430	9·990243	9·331187	10.668813	10.009757	10.678570	54
7	9·322019	9·990215	9·331803	10.668197	10.009785	10.677981	53
8	9·322607	9·990188	9·332418	10.667582	10.009812	10.677393	52
9	9·323194	9·990161	9·333033	10.666967	10.009839	10.676806	51
10	9·323780	9·990134	9·333646	10.666354	10.009866	10.676220	50
11	9·324366	9·990107	9·334259	10.665741	10.009893	10.675634	49
12	9·324951	9·990079	9·334871	10.665129	10.009921	10.675049	48
13	9·325534	9·990052	9·335482	10.664518	10.009948	10.674466	47
14	9·326117	9·990025	9·336093	10.663907	10.009975	10.673883	46
15	9·326700	9·989997	9·336702	10.663298	10.010003	10.673300	45
16	9·327281	9·989970	9·337311	10.662689	10.010030	10.672719	44
17	9·327861	9·989942	9·337919	10.662081	10.010058	10.672138	43
18	9·328442	9·989915	9·338527	10.661473	10.010085	10.671558	42
19	9·329021	9·989887	9·339133	10.660867	10.010113	10.670979	41
20	9·329599	9·989860	9·339739	10.660261	10.010140	10.670401	40
21	9·330176	9·989832	9·340344	10.659656	10.010168	10.669824	39
22	9·330753	9·989804	9·340948	10.659052	10.010196	10.669247	38
23	9·331328	9·989777	9·341552	10.658448	10.010223	10.668672	37
24	9·331903	9·989749	9·342155	10.657845	10.010251	10.668097	36
25	9·332478	9·989721	9·342757	10.657243	10.010279	10.667522	35
26	9·333051	9·989693	9·343358	10.656642	10.010307	10.666949	34
27	9·333624	9·989665	9·343958	10.656042	10.010335	10.666376	33
28	9·334195	9·989637	9·344558	10.655442	10.010363	10.665805	32
29	9·334766	9·989609	9·345157	10.654843	10.010391	10.665234	31
30	9·335337	9·989581	9·345755	10.654245	10.010419	10.664663	30
		Sine		Tangent		Secant	Minutes

77 Degrees.

12 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.335337	9.989581	9.345755	10.654245	10.010419	10.664663	30
31	9.335906	9.989553	9.346353	10.653647	10.010447	10.664094	29
32	9.336475	9.989525	9.346949	10.653051	10.010475	10.663525	28
33	9.337043	9.989497	9.347545	10.652455	10.010503	10.662957	27
34	9.337610	9.989469	9.348141	10.651859	10.010531	10.662390	26
35	9.338176	9.989441	9.348735	10.651265	10.010559	10.661824	25
36	9.338742	9.989413	9.349329	10.650671	10.010587	10.661258	24
37	9.339306	9.989384	9.349922	10.650078	10.010616	10.660694	23
38	9.339871	9.989356	9.350514	10.649486	10.010644	10.660129	22
39	9.340434	9.989328	9.351106	10.648894	10.010672	10.659566	21
40	9.340996	9.989299	9.351697	10.648303	10.010701	10.659004	20
41	9.341558	9.989271	9.352287	10.647713	10.010729	10.658442	19
42	9.342119	9.989243	9.352876	10.647124	10.010757	10.657881	18
43	9.342679	9.989214	9.353465	10.646535	10.010786	10.657321	17
44	9.343239	9.989186	9.354053	10.645947	10.010814	10.656761	16
45	9.343797	9.989157	9.354640	10.645360	10.010843	10.656203	15
46	9.344355	9.989128	9.355227	10.644773	10.010872	10.655645	14
47	9.344912	9.989100	9.355813	10.644187	10.010900	10.655088	13
48	9.345469	9.989071	9.356398	10.643602	10.010929	10.654531	12
49	9.346024	9.989042	9.356982	10.643018	10.010958	10.653976	11
50	9.346579	9.989014	9.357566	10.642434	10.010986	10.653421	10
51	9.347134	9.988985	9.358149	10.641851	10.011015	10.652866	9
52	9.347687	9.988956	9.358731	10.641269	10.011044	10.652313	8
53	9.348240	9.988927	9.359313	10.640687	10.011073	10.651760	7
54	9.348792	9.988898	9.359893	10.640107	10.011102	10.651208	6
55	9.349343	9.988869	9.360474	10.639526	10.011131	10.650657	5
56	9.349893	9.988840	9.361053	10.638947	10.011160	10.650107	4
57	9.350443	9.988811	9.361632	10.638368	10.011189	10.649557	3
58	9.350992	9.988782	9.362210	10.637790	10.011218	10.649008	2
59	9.351540	9.988753	9.362787	10.637213	10.011247	10.648460	1
60	9.352088	9.988724	9.363364	10.636636	10.011276	10.647912	0
		Sine		Tangent		Secant	Minutes

77 Degrees.

13 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.352088	9.988724	9.363364	10.636636	10.011276	10.647912	60
1	9.352635	9.988695	9.363940	10.636060	10.011305	10.647365	59
2	9.353181	9.988666	9.364516	10.635484	10.011334	10.646819	58
3	9.353726	9.988636	9.365090	10.634910	10.011364	10.646274	57
4	9.354271	9.988607	9.365664	10.634336	10.011393	10.645729	56
5	9.354815	9.988578	9.366237	10.633763	10.011422	10.645185	55
6	9.355358	9.988548	9.366810	10.633190	10.011452	10.644642	54
7	9.355901	9.988519	9.367382	10.632618	10.011481	10.644099	53
8	9.356443	9.988489	9.367953	10.632047	10.011511	10.643557	52
9	9.356984	9.988460	9.368524	10.631476	10.011540	10.643016	51
10	9.357524	9.988430	9.369094	10.630906	10.011570	10.642476	50
11	9.358064	9.988401	9.369663	10.630337	10.011599	10.641936	49
12	9.358603	9.988371	9.370231	10.629769	10.011629	10.641397	48
13	9.359141	9.988342	9.370799	10.629201	10.011658	10.640859	47
14	9.359679	9.988312	9.371367	10.628633	10.011688	10.640321	46
15	9.360215	9.988282	9.371933	10.628067	10.011718	10.639785	45
16	9.360751	9.988252	9.372499	10.627501	10.011748	10.639249	44
17	9.361287	9.988223	9.373064	10.626936	10.011777	10.638713	43
18	9.361822	9.988193	9.373629	10.626371	10.011807	10.638178	42
19	9.362356	9.988163	9.374193	10.625807	10.011837	10.637644	41
20	9.362889	9.988133	9.374756	10.625244	10.011867	10.637111	40
21	9.363422	9.988103	9.375319	10.624681	10.011897	10.636578	39
22	9.363954	9.988073	9.375881	10.624119	10.011927	10.636046	38
23	9.364485	9.988043	9.376442	10.623558	10.011957	10.635515	37
24	9.365016	9.988013	9.377003	10.622997	10.011987	10.634984	36
25	9.365546	9.987983	9.377563	10.622437	10.012017	10.634454	35
26	9.366075	9.987952	9.378123	10.621877	10.012048	10.633925	34
27	9.366604	9.987922	9.378681	10,621319	10.012078	10.633396	33
28	9.367132	9.987892	9.379239	10.620761	10.012108	10.632868	32
29	9.367659	9.987862	9.379797	10.620203	10.012138	10.632341	31
30	9.368185	9.987831	9.380354	10.619646	10.012169	10.631815	30
		Sine		Tangent		Secant	Minutes

76 Degrees.

13 Degrees.

Sine		Tangent		Secant		
9.368185	9.987831	9.380354	10.619646	10.012169	10.631815	30
9.368711	9.987801	9.380910	10.619090	10.012199	10.631289	29
9.369236	9.987771	9.381465	10.618535	10.012229	10.630764	28
9.369761	9.987740	9.382020	10.617980	10.012260	10.630239	27
9.370285	9.987710	9.382575	10.617425	10.012290	10.629715	26
9.370808	9.987679	9.383129	10.616871	10.012321	10.629192	25
9.371330	9.987649	9.383682	10.616318	10.012351	10.628670	24
9.371852	9.987618	9.384234	10.615766	10.012382	10.628148	23
9.372373	9.987588	9.384786	10.615214	10.012412	10.627627	22
9.372894	9.987557	9.385337	10.614663	10.012443	10.627106	21
9.373414	9.987526	9.385888	10.614112	10.012474	10.626586	20
9.373933	9.987495	9.386438	10.613562	10.012505	10.626067	19
9.374452	9.987465	9.386987	10.613013	10.012535	10.625548	18
9.374970	9.987434	9.387536	10.612464	10.012566	10.625030	17
9.375487	9.987403	9.388084	10.611916	10.012597	10.624513	16
9.376003	9.987372	9.388631	10.611369	10.012628	10 623997	15
9.376519	9.987341	9.389178	10.610822	10.012659	10.623481	14
9.377035	9.987310	9.389724	10.610276	10.012690	10.622965	13
9.377549	9.987279	9.390270	10.609730	10.012721	10.622451	12
9.378063	9.987248	9.390815	10.609185	10.012752	10.621937	11
9.378577	9.987217	9.391359	10.608641	10.012783	10.621423	10
9.379089	9.987186	9.391903	10.608097	10.012814	10.620911	9
9.379601	9.987155	9.392447	10.607553	10.012845	10.620399	8
9.380113	9.987124	9.392989	10.607011	10.012876	10.619887	7
9.380624	9.987092	9.393531	10.606469	10.012908	10.619376	6
9.381134	9.987061	9.394073	10.605927	10.012939	10.618866	5
9.381643	9.987030	9.394614	10.605386	10.012970	10.618357	4
9.382152	9.986998	9.395154	10.604846	10.013002	10.617848	3
9.382660	9.986967	9.395693	10.604307	10.013033	10.617340	2
9.383168	9.986936	9.396233	10.603767	10.013064	10.616832	1
9.383675	9.986904	9.396771	10.603229	10.013096	10.616325	0
	Sine		Tangent		Secant	Minutes

76 Degrees.

14 Degrees.

Minutes	Sine		Tangent		Secant	
0	9.383675	9.986904	9.396771	10.603229	10.013096	10.616325
1	9.384181	9.986873	9.397309	10.602691	10.013127	10.615819
2	9.384687	9.986841	9.397846	10.602154	10.013159	10.615313
3	9.385192	9.986809	9.398383	10.601617	10.013191	10.614808
4	9.385697	9.986778	9.398919	10.601081	10.013222	10.614303
5	9.386201	9.986746	9.399455	10.600545	10.013254	10.613799
6	9.386704	9.986714	9.399990	10.600010	10.013286	10.613296
7	9.387207	9.986683	9.400524	10.599476	10.013317	10.612793
8	9.387709	9.986651	9.401058	10.598942	10.013349	10.612291
9	9.388210	9.986619	9.401591	10.598409	10.013381	10.611790
10	9.388711	9.986587	9.402124	10.597876	10.013413	10.611289
11	9.389211	9.986555	9.402656	10.597344	10.013445	10.610789
12	9.389711	9.986523	9.403187	10.596813	10.013477	10.610289
13	9.390210	9.986491	9.403718	10.596282	10.013509	10.609790
14	9.390708	9.986459	9.404249	10.595751	10.013541	10.609292
15	9.391206	9.986427	9.404778	10.595222	10.013573	10.608794
16	9.391703	9.986395	9.405308	10.594692	10.013605	10.608297
17	9.392199	9.986363	9.405836	10.594164	10.013637	10.607801
18	9.392695	9.986331	9.406364	10.593636	10.013669	10.607305
19	9.393190	9.986299	9.406892	10.593108	10.013701	10.606810
20	9.393685	9.986266	9.407419	10.592581	10.013734	10.606315
21	9.394179	9.986234	9.407945	10.592055	10.013766	10.605821
22	9.394673	9.986202	9.408471	10.591529	10.013798	10.605327
23	9.395166	9.986169	9.408997	10.591003	10.013831	10.604834
24	9.395658	9.986137	9.409521	10.590479	10.013863	10.604342
25	9.396150	9.986104	9.410045	10.589955	10.013896	10.603850
26	9.396641	9.986072	9.410569	10.589431	10.013928	10.603359
27	9.397132	9.986039	9.411092	10.588908	10.013961	10.602868
28	9.397621	9.986007	9.411615	10.588385	10.013993	10.602379
29	9.398111	9.985974	9.412137	10.587863	10.014026	10.601889
30	9.398600	9.985942	9.412658	10.587342	10.014058	10.601400
		Sine		Tangent		Secant

75 Degrees.

14 Degrees.

	Sine		Tangent		Secant		
0	9.398600	9.985942	9.412658	10.587342	10.014058	10.601400	30
1	9.399088	9.985909	9.413179	10.586821	10.014091	10.600912	29
2	9.399575	9.985876	9.413699	10.586301	10.014124	10.600425	28
3	9.400062	9.985843	9.414219	10.585781	10.014157	10.599938	27
4	9.400549	9.985811	9.414738	10.585262	10.014189	10.599451	26
5	9.401035	9.985778	9.415257	10.584743	10.014222	10.598965	25
6	9.401520	9.985745	9.415775	10.584225	10.014255	10.598480	24
7	9.402005	9.985712	9.416293	10.583707	10.014288	10.597995	23
8	9.402489	9.985679	9.416810	10.583190	10.014321	10.597511	22
9	9.402972	9.985646	9.417326	10.583674	10.014354	10.597028	21
0	9.403455	9.985613	9.417842	10.582158	10.014387	10.596545	20
1	9.403938	9.985580	9.418358	10.581642	10.014420	10.596062	19
2	9.404420	9.985547	9.418873	10.581127	10.014453	10.595580	18
3	9.404901	9.985513	9.419387	10.580613	10.014487	10.595099	17
4	9.405382	9.985480	9.419901	10.580099	10.014520	10.594618	16
5	9.405862	9.985447	9.420415	10.579585	10.014553	10.594138	15
6	9.406341	9.985414	9.420927	10.579073	10.014586	10.593659	14
7	9.406820	9.985380	9.421440	10.578560	10.014620	10.593180	13
8	9.407299	9.985347	9.421951	10.578049	10.014653	10.592701	12
9	9.407777	9.985314	9.422463	10.577537	10.014686	10.592223	11
0	9.408254	9.985280	9.422973	10.577027	10.014720	10.591746	10
1	9.408731	9.985247	9.423484	10.576516	10.014753	10.591269	9
2	9.409207	9.985213	9.423993	10.576007	10.014787	10 590793	8
3	9.409682	9.985180	9.424503	10.575497	10.014820	10.590318	7
4	9.410157	9.985146	9.425011	10.574989	10.014854	10.589843	6
5	9.410632	9.985112	9.425519	10.574481	10.014888	10.589368	5
6	9.411106	9.985079	9.426027	10.573973	10.014921	10.588894	4
7	9.411579	9.985045	9.426534	10.573466	10.014955	10.588421	3
8	9.412052	9.985011	9.427041	10.572959	10.014989	10.587948	2
9	9.412524	9.984978	9.427547	10.572453	10.015022	10.587476	1
0	9.412996	9.984944	9.428052	10.571948	10.015056	10.587004	0
		Sine		Tangent		Secant	Minutes

75 Degrees.

15 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.412996	9.984944	9.428052	10.571948	10.015056	10.587004	60
1	9.413467	9.984910	9.428557	10.571443	10.015090	10.586533	59
2	9.413938	9.984876	9.429062	10.570938	10.015124	10.586062	58
3	9.414408	9.984842	9.429566	10.570434	10.015158	10.585592	57
4	9.414878	9.984808	9.430070	10.569930	10.015192	10.585122	56
5	9.415347	9.984774	9.430573	10.569427	10.015226	10.584653	55
6	9.415815	9.984740	9.431075	10.568925	10.015260	10.584185	54
7	9.416283	9.984706	9.431577	10.568423	10.015294	10.583717	53
8	9.416751	9.984672	9.432079	10.567921	10.015328	10.583249	52
9	9.417217	9.984637	9.432580	10.567420	10.015363	10.582783	51
10	9.417684	9.984603	9.433080	10.566920	10.015397	10.582316	50
11	9.418149	9.984569	9.433580	10.566420	10.015431	10.581851	49
12	9.418615	9.984535	9.434080	10.565920	10.015465	10.581385	48
13	9.419079	9.984500	9.434579	10.565421	10.015500	10.580921	47
14	9.419544	9.984466	9.435078	10.564922	10.015534	10.580456	46
15	9.420007	9.984432	9.435576	10.564424	10.015568	10.579993	45
16	9.420470	9.984397	9.436073	10.563927	10.015603	10.579530	44
17	9.420933	9.984363	9.436570	10.563430	10.015637	10.579067	43
18	9.421395	9.984328	9.437067	10.562933	10.015672	10.578605	42
19	9.421857	9.984293	9.437563	10.562437	10.015707	10.578143	41
20	9.422318	9.984259	9.438059	10.561941	10.015741	10.577682	40
21	9.422778	9.984224	9.438554	10.561446	10.015776	10.577222	39
22	9.423238	9.984189	9.439048	10.560952	10.015811	10.576762	38
23	9.423697	9.984155	9.439543	10.560457	10.015845	10.576303	37
24	9.424156	9.984120	9.440036	10.559964	10.015880	10.575844	3
25	9.424615	9.984085	9.440529	10.559471	10.015915	10.575385	35
26	9.425073	9.984050	9.441022	10.558978	10.015950	10.574927	34
27	9.425530	9.984015	9.441514	10.558486	10.015985	10.574470	33
28	9.425987	9.983981	9.442006	10.557994	10.016019	10.574013	32
29	9.426443	9.983946	9.442497	10.557503	10.016054	10.573557	31
30	9.426899	9.983910	9.442988	10.557012	10.016090	10.573101	30
		Sine		Tangent		Secant	Minutes

74 Degrees.

15 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.426899	9.983910	9.442988	10.557012	10.016090	10.573101	30
1	9.427354	9.983875	9.443479	10.556521	10.016125	10.572646	29
2	9.427809	9.983840	9.443968	10.556032	10.016160	10.572191	28
3	9.428263	9.983805	9.444458	10.555542	10.016195	10.571737	27
4	9.428717	9.983770	9.444947	10.555053	10.016230	10.571283	26
5	9.429170	9.983735	9.445435	10.554565	10.016265	10.570830	25
6	9.429623	9.983700	9.445923	10.554077	10.016300	10.570377	24
7	9.430075	9.983664	9.446411	10.553589	10.016336	10.569925	23
8	9.430527	9.983629	9.446898	10.553102	10.016371	10.569473	22
9	9.430978	9.983594	9.447384	10.552616	10.016406	10.569022	21
0	9.431429	9.983558	9.447870	10.552130	10.016442	10.568571	20
1	9.431879	9.983523	9.448356	10.551644	10.016477	10.568121	19
2	9.432328	9.983487	9.448841	10.551159	10.016513	10.567672	18
3	9.432778	9.983452	9.449326	10.550674	10.016548	10.567222	17
4	9.433226	9.983416	9.449810	10.550190	10.016584	10.566774	16
5	9.433675	9.983380	9.450294	10.549706	10.016620	10.566325	15
6	9.434122	9.983345	9.450777	10.549223	10.016655	10.565878	14
7	9.434569	9.983309	9.451260	10.548740	10.016691	10.565431	13
8	9.435016	9.983273	9.451743	10.548257	10.016727	10.564984	12
9	9.435462	9.983238	9.452225	10.547775	10.016762	10.564538	11
0	9.435908	9.983202	9.452706	10.547294	10.016798	10.564092	10
1	9.436353	9.983166	9.453187	10.546813	10.016834	10.563647	9
2	9.436798	9.983130	9.453668	10.546332	10.016870	10.563202	8
3	9.437242	9.983094	9.454148	10.545852	10.016906	10.562758	7
4	9.437686	9.983058	9.454628	10.545372	10.016942	10.562314	6
5	9.438129	9.983022	9.455107	10.544893	10.016978	10.561871	5
6	9.438572	9.982986	9.455586	10.544414	10.017014	10.561428	4
7	9.439014	9.982950	9.456064	10.543936	10.017050	10.560986	3
8	9.439456	9.982914	9.456542	10.543458	10.017086	10.560544	2
9	9.439897	9.982878	9.457019	10.542981	10.017122	10.560103	1
0	9.440338	9.982842	9.457496	10.542504	10.017158	10.559662	0
		Sine		Tangent		Secant	Minutes

74 Degrees.

16 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.440338	9.982842	9.457496	10.542504	10.017158	10.559662	60
1	9.440778	9.982805	9.457973	10.542027	10.017195	10.559222	59
2	9.441218	9.982769	9.458449	10.541551	10.017231	10.558782	58
3	9.441658	9.982733	9.458925	10.541075	10.017267	10.558342	57
4	9.442096	9.982696	9.459400	10.540600	10.017304	10.557904	56
5	9.442535	9.982660	9.459875	10.540125	10.017340	10.557465	55
6	9.442973	9.982624	9.460349	10.539651	10.017376	10.557027	54
7	9.443410	9.982587	9.460823	10.539177	10.017413	10.556590	53
8	9.443847	9.982551	9.461297	10.538703	10.017449	10.556153	52
9	9.444284	9.982514	9.461770	10.538230	10.017486	10.555716	51
10	9.444720	9.982477	9.462242	10.537758	10.017523	10.555280	50
11	9.445155	9.982441	9.462714	10.537286	10.017559	10.554845	49
12	9.445590	9.982404	9.463186	10.536814	10.017596	10.554410	48
13	9.446025	9.982367	9.463658	10.536342	10.017633	10.553975	47
14	9.446459	9.982331	9.464128	10.535872	10.017669	10.553541	46
15	9.446893	9.982294	9.464599	10.535401	10.017706	10.553107	45
16	9.447326	9.982257	9.465069	10.534931	10.017743	10.552674	44
17	9.447759	9.982220	9.465539	10.534461	10.017780	10.552241	43
18	9.448191	9.982183	9.466008	10.533992	10.017817	10.551809	42
19	9.448623	9.982146	9.466476	10.533524	10.017854	10.551377	41
20	9.449054	9.982109	9.466945	10.533055	10.017891	10.550946	40
21	9.449485	9.982072	9.467413	10.532587	10.017928	10.550515	39
22	9.449915	9.982035	9.467880	10.532120	10.017965	10.550085	38
23	9.450345	9.981998	9.468347	10.531653	10.018002	10.549655	37
24	9.450775	9.981961	9.468814	10.531186	10.018039	10.549225	36
25	9.451204	9.981924	9.469280	10.530720	10.018076	10.548796	35
26	9.451632	9.981886	9.469746	10.530254	10.018114	10.548368	34
27	9.452060	9.981849	9.470211	10.529789	10.018151	10.547940	33
28	9.452488	9.981812	9.470676	10.529324	10.018188	10.547512	32
29	9.452915	9.981774	9.471141	10.528859	10.018226	10.547085	31
30	9.453342	9.981737	9.471605	10.528395	10.018263	10.546658	30
		Sine		Tangent		Secant	Minntes

73 Degrees.

16 Degrees.

Sine		Tangent		Secant		
9.453342	9.981737	9.471605	10.528395	10.018263	10.546658	30
9.453768	9.981699	9.472068	10.527932	10.018301	10.546232	29
9 454194	9.981662	9.472532	10.527468	10.018338	10.545806	28
9.454619	9.981625	9.472995	10.527005	10.018375	10.545381	27
9.455044	9.981587	9.473457	10.526543	10.018413	10.544956	26
9.455469	9.981549	9.473919	10.526081	10.018451	10.544531	25
9.455893	9.981512	9.474381	10.525619	10.018488	10.544107	24
9.456316	9.981474	9.474842	10.525158	10.018526	10.543684	23
9.456739	9.981436	9.475303	10.524697	10.018564	10.543261	22
9.457162	9.981399	9.475763	10.524237	10.018601	10.542838	21
9.457584	9.981361	9.476223	10.523777	10.018639	10.542416	20
9.458006	9.981323	9.476683	10.523317	10.018677	10.541994	19
9.458427	9.981285	9.477142	10.522858	10.018715	10.541573	18
9.458848	9.981247	9.477601	10.522399	10.018753	10.541152	17
9.459268	9.981209	9.478059	10.521941	10.018791	10.540732	16
9.459688	9.981171	9.478517	10.521483	10.018829	10.540312	15
9.460108	9.981133	9.478975	10.521025	10.018867	10.539892	14
9.460527	9.981095	9.479432	10.520568	10.018905	10.539473	13
9.460946	9.981057	9.479889	10.520111	10.018943	10.539054	12
9.461364	9.981019	9.480345	10.519655	10.018981	10.538636	11
9.461782	9.980980	9.480801	10.519199	10.019020	10.538218	10
9.462199	9.980942	9.481257	10.518743	10.019058	10.537801	9
9.462616	9.980904	9.481712	10.518288	10.019096	10.537384	8
9.463032	9.980866	9.482167	10.517833	10.019134	10.536968	7
9.463448	9.980827	9.482621	10.517379	10.019173	10.536552	6
9.463864	9.980789	9.483075	10.516925	10.019211	10.536136	5
9.464279	9.980751	9.483529	10.516471	10.019249	10.535721	4
9.464694	9.980712	9.483982	10.516018	10.019288	10.535306	3
9.465108	9.980673	9.484435	10.515565	10.019327	10.534892	2
9.465522	9.980635	9.484887	10.515113	10.019365	10.534478	1
9.465935	9.980596	9.485339	10.514661	10.019404	10.534065	0
	Sine		Tangent		Secant	Minutes

73 Degrees.

17 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.465935	9.980596	9.485339	10.514661	10.019404	10.534065	60
1	9.466348	9.980558	9.485791	10.514209	10.019442	10.533652	59
2	9.466761	9.980519	9.486242	10.513758	10.019481	10.533239	58
3	9.467173	9.980480	9.486693	10.513307	10.019520	10.532827	57
4	9.467585	9.980441	9.487143	10.512857	10.019559	10.532415	56
5	9.467996	9.980403	9.487593	10.512407	10.019597	10.532004	55
6	9.468407	9.980364	9.488043	10.511957	10.019636	10.531593	54
7	9.468817	9.980325	9.488492	10.511508	10.019675	10.531183	53
8	9.469227	9.980286	9.488941	10.511059	10.019714	10.530773	52
9	9.469637	9.980247	9.489390	10.510610	10.019753	10.530363	51
10	9.470046	9.980208	9.489838	10.510162	10.019792	10.529954	50
11	9.470455	9.980169	9.490286	10.509714	10.019831	10.529545	49
12	9.470863	9.980130	9.490733	10.509267	10.019870	10.529137	48
13	9.471271	9.980091	9.491180	10.508820	10.019909	10.528729	47
14	9.471678	9.980052	9.491627	10.508373	10.019948	10.528322	46
15	9.472086	9.980012	9.492073	10.507927	10.019988	10.527914	45
16	9.472492	9.979973	9.492519	10.507481	10.020027	10.527508	44
17	9.472898	9.979934	9.492965	10.507035	10.020066	10.527102	43
18	9.473304	9.979895	9.493410	10.506590	10.020105	10.526696	42
19	9.473710	9.979855	9.493854	10.506146	10.020145	10.526290	41
20	9.474115	9.979816	9.494299	10.505701	10.020184	10.525885	40
21	9.474519	9.979776	9.494743	10.505257	10.020224	10.525481	39
22	9.474923	9.979737	9.495186	10.504814	10.020263	10.525077	38
23	9.475327	9.979697	9.495630	10.504370	10.020303	10.524673	37
24	9.475730	9.979658	9.496073	10.503927	10.020342	10.524270	36
25	9.476133	9.979618	9.496515	10.503485	10.020382	10.523867	35
26	9.476536	9.979578	9.496957	10.503043	10.020422	10.523464	34
27	9.476938	9.979539	9.497399	10.502601	10.020461	10.523062	33
28	9.477340	9.979499	9.497841	10.502159	10.020501	10.522660	32
29	9.477741	9.979459	9.498282	10.501718	10.020541	10.522259	31
30	9.478142	9.979419	9.498722	10.501278	10.020581	10.521858	30
		Sine		Tangent		Secant	Minutes

72 Degrees.

17 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.478142	9.979419	9.498722	10.501278	10.020581	10.521858	30
31	9.478542	9.979380	9.499163	10.500837	10.020620	10.521458	29
32	9.478942	9.979340	9.499603	10.500397	10.020660	10.521058	28
33	9.479342	9.979300	9.500042	10.499958	10.020700	10.520658	27
34	9.479741	9.979260	9.500481	10.499519	10.020740	10.520259	26
35	9.480140	9.979220	9.500920	10.499080	10.020780	10.519860	25
36	9.480536	9.979180	9.501359	10.498641	10.020820	10.519462	24
37	9.480937	9.979140	9.501797	10.498203	10.020860	10.519063	23
38	9.481334	9.979100	9.502235	10.497765	10.020900	10.518666	22
39	9.481731	9.979059	9.502672	10.497328	10.020941	10.518269	21
40	9.482128	9.979019	9.503109	10.496891	10.020981	10.517872	20
41	9.482525	9.978979	9.503546	10.496454	10.021021	10.517475	19
42	9.482921	9.978939	9.503982	10.496018	10.021061	10.517079	18
43	9.483316	9.978898	9.504418	10.495582	10.021102	10.516684	17
44	9.483712	9.978858	9.504854	10.495146	10.021142	10.516288	16
45	9.484107	9.978817	9.505289	10.494711	10.021183	10.515893	15
46	9.484501	9.978777	9.505724	10.494276	10.021223	10.515499	14
47	9.484895	9.978736	9.506159	10.493841	10.021264	10.515105	13
48	9.485289	9.978696	9.506593	10.493407	10.021304	10.514711	12
49	9.485682	9.978655	9.507027	10.492973	10.021345	10.514318	11
50	9.486075	9.978615	9.507460	10.492540	10.021385	10.513925	10
51	9.486467	9.978574	9.507893	10.492107	10.021426	10.513533	9
52	9.486859	9.978533	9.508326	10.491674	10.021467	10.513141	8
53	9.487251	9.978493	9.508759	10.491241	10.021507	10.512749	7
54	9.487643	9.978452	9.509191	10.490809	10.021548	10.512357	6
55	9.488033	9.978411	9.509622	10.490378	10.021589	10.511967	5
56	9.488424	9.978370	9.510054	10.489946	10.021630	10.511576	4
57	9.488814	9.978329	9.510485	10.489515	10.021671	10.511186	3
58	9.489204	9.978288	9.510916	10.489084	10.021712	10.510796	2
59	9.489593	9.978247	9.511346	10.488654	10.021753	10.510407	1
60	9.489982	9.978206	9.511776	10.488224	10.021794	10.510018	0
		Sine		Tangent		Secant	Minutes

72 Degrees.

18 Degrees.

Min.	Sine		Tangent		Secant		
0	9.489982	9.978206	9.511776	10.488224	10.021794	10.510018	60
1	9.490371	9.978165	9.512206	10.487794	10.021835	10.509629	59
2	9.490759	9.978124	9.512635	10.487365	10.021876	10.509241	58
3	9.491147	9.978083	9.513064	10.486936	10.021917	10.508853	57
4	9.491534	9.978042	9.513493	10.486507	10.021958	10.508466	56
5	9.491922	9.978001	9.513921	10.486079	10.021999	10.508078	55
6	9.492308	9.977959	9.514349	10.485651	10.022041	10.507692	54
7	9.492695	9.977918	9.514777	10.485223	10.022082	10.507305	53
8	9.493081	9.977878	9.515204	10.484796	10.022122	10.506919	52
9	9.493466	9.977835	9.515631	10.484369	10.022165	10.506534	51
10	9.493851	9.977794	9.516057	10.483943	10.022206	10.506149	50
11	9.494236	9.977752	9.516484	10.483516	10.022248	10.505764	49
12	9.494620	9.977711	9.516910	10.483090	10.022289	10.505380	48
13	9.495005	9.977669	9.517335	10.482665	10.022331	10.504995	47
14	9.495388	9.977628	9.517761	10.482239	10.022372	10.504612	46
15	9.495772	9.977586	9.518185	10.481815	10.022414	10.504228	45
16	9.496154	9.977544	9.518610	10.481390	10.022456	10.503846	44
17	9.496537	9.977503	9.519034	10.480966	10.022497	10.503463	43
18	9.496919	9.977461	9.519458	10.480542	10.022539	10.503081	42
19	9.497301	9.977419	9.519882	10.480118	10.022581	10.502699	41
20	9.497682	9.977377	9.520305	10.479695	10.022623	10.502318	40
21	9.498063	9.977335	9.520728	10.479272	10.022665	10.501937	39
22	9.498444	9.977293	9.521151	10.478849	10.022707	10.501556	38
23	9.498824	9.977251	9.521573	10.478427	10.022749	10.501176	37
24	9.499204	9.977209	9.521995	10.478005	10.022791	10.500796	36
25	9.499584	9.977167	9.522417	10.477583	10.022833	10.500416	35
26	9.499963	9.977125	9.522838	10.477162	10.022875	10.500037	34
27	9.500342	9.977083	9.523259	10.476741	10.022917	10.499658	33
28	9.500721	9.977041	9.523679	10.476321	10.022959	10.499279	32
29	9.501099	9.976999	9.524100	10.475900	10.023001	10.498901	31
30	9.501476	9.976957	9.524520	10.475480	10.023043	10.498524	30
		Sine		Tangent		Secant	Minutes

71 Degrees.

18 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.501476	9.976957	9.524520	10.475480	10.023043	10.498524	30
31	9.501854	9.976914	9.524939	10.475061	10.023086	10.498146	29
32	9.502231	9.976872	9.525359	10.474641	10.023128	10.497769	28
33	9.502607	9.976830	9.525778	10.474222	10.023170	10.497393	27
34	9.502984	9.976787	9.526197	10.473803	10.023213	10.497016	26
35	9.503360	9.976745	9.526615	10.473385	10.023255	10.496640	25
36	9.503735	9.976702	9.527033	10.472967	10.023298	10.496265	24
37	9.504110	9.976660	9.527451	10.472549	10.023340	10.495890	23
38	9.504485	9.976617	9.527868	10.472132	10.023383	10.495515	22
39	9.504860	9.976574	9.528285	10.471715	10.023426	10.495140	21
40	9.505234	9.976532	9.528702	10.471298	10.023468	10.494766	20
41	9.505608	9.976489	9.529119	10.470881	10.023511	10.494392	19
42	9.505981	9.976446	9.529535	10.470465	10.023554	10.494019	18
43	9.506354	9.976404	9.529950	10.470050	10.023596	10.493646	17
44	9.506727	9.976361	9.530366	10.469634	10.023639	10.493273	16
45	9.507099	9.976318	9.530781	10.469219	10.023682	10.492901	15
46	9.507471	9.976275	9.531196	10.468804	10.023725	10.492529	14
47	9.507843	9.976232	9.531611	10.468389	10.023768	10.492157	13
48	9.508214	9.976189	9.532025	10.467975	10.023811	10.491786	12
49	9.508585	9.976146	9.532439	10.467561	10.023854	10.491415	11
50	9.508956	9.976103	9.532853	10.467147	10.023897	10.491044	10
51	9.509326	9.976060	9.533266	10.466734	10.023940	10.490674	9
52	9.509696	9.976017	9.533679	10.466321	10.023983	10.490304	8
53	9.510065	9.975974	9.534092	10.465908	10.024026	10.489935	7
54	9.510434	9.975930	9.534504	10.465496	10.024070	10.489566	6
55	9.510803	9.975887	9.534916	10.465084	10.024113	10.489197	5
56	9.511172	9.975844	9.535328	10.464672	10.024156	10.488828	4
57	9.511540	9.975800	9.535739	10.464261	10.024200	10.488460	3
58	9.511907	9.975757	9.536150	10.463850	10.024243	10.488093	2
59	9.512275	9.975713	9.536561	10.463439	10.024287	10.487725	1
60	9.512642	9.975670	9.536972	10.463028	10.024330	10.487358	0
		Sine		Tangent		Secant	Minutes

71 Degrees.

19 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.512642	9.975670	9.536972	10.463028	10.024330	10.487358	60
1	9.513009	9.975626	9.537382	10.462618	10.024374	10.486991	59
2	9.513375	9.975583	9.537792	10.462208	10.024417	10.486625	58
3	9.513741	9.975539	9.538202	10.461798	10.024461	10.486259	57
4	9.514107	9.975496	9.538611	10.461389	10.024504	10.485893	56
5	9.514472	9.975452	9.539020	10.460980	10.024548	10.485528	55
6	9.514837	9.975408	9.539429	10.460571	10.024592	10.485163	54
7	9.515202	9.975365	9.539837	10.460163	10.024635	10.484798	53
8	9.515566	9.975321	9.540245	10.459755	10.024679	10.484434	52
9	9.515930	9.975277	9.540653	10.459347	10.024723	10.484070	51
10	9.516294	9.975233	9.541061	10.458939	10.024767	10.483706	50
11	9.516657	9.975189	9.541468	10.458532	10.024811	10.483343	49
12	9.517020	9.975145	9.541875	10.458125	10.024855	10.482980	48
13	9.517382	9.975101	9.542281	10.457719	10.024899	10.482618	47
14	9.517745	9.975057	9.542688	10.457312	10.024943	10.482255	46
15	9.518107	9.975013	9.543094	10.456906	10.024987	10.481893	45
16	9.518468	9.974969	9.543499	10.456501	10.025031	10.481532	44
17	9.518829	9.974925	9.543905	10.456095	10.025075	10.481171	43
18	9.519190	9.974880	9.544310	10.455690	10.025120	10.480810	42
19	9.519551	9.974836	9.544715	10.455285	10.025164	10.480449	41
20	9.519911	9.974792	9.545119	10.454881	10.025208	10.480089	40
21	9.520271	9.974747	9.545524	10.454476	10.025253	10.479729	39
22	9.520631	9.974703	9.545928	10.454072	10.025297	10.479369	38
23	9.520990	9.974659	9.546331	10.453669	10.025341	10.479010	37
24	9.521349	9.974614	9.546735	10.453265	10.025386	10.478651	36
25	9.521707	9.974570	9.547138	10.452862	10.025430	10.478293	35
26	9.522066	9.974525	9.547540	10.452460	10.025475	10.477934	34
27	9.522423	9.974481	9.547943	10.452057	10.025519	10.477577	33
28	9.522781	9.974436	9.548345	10.451655	10.025564	10.477219	32
29	9.523138	9.974391	9.548747	10.451253	10.025609	10.476862	31
30	9.523495	9.974347	9.549149	10.450851	10.025653	10.476505	30
		Sine		Tangent		Secant	Minutes

70 Degrees.

19 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.523495	9.974347	9.549149	10.450851	10.025653	10.476505	30
31	9.523852	9.974302	9.549550	10.450450	10.025698	10.476148	29
32	9.524208	9.974257	9.549951	10.450049	10.025743	10.475792	28
33	9.524564	9.974212	9.550352	10.449648	10.025788	10.475436	27
34	9.524920	9.974167	9.550752	10.449248	10.025833	10.475080	26
35	9.525275	9.974122	9.551152	10.448848	10.025878	10.474725	25
36	9.525630	9.974077	9.551552	10.448448	10.025923	10.474370	24
37	9.525984	9.974032	9.551952	10.448048	10.026968	10.474016	23
38	9.526339	9.973987	9.552351	10.447649	10.026013	10.473661	22
39	9.526693	9.973942	9.552750	10.447250	10.026058	10.473307	21
40	9.527046	9.973897	9.553149	10.446851	10.026103	10.472954	20
41	9.527400	9.973852	9.553548	10.446452	10.026148	10.472600	19
42	9.527753	9.973807	9.553946	10.446054	10.026193	10.472247	18
43	9.528105	9.973761	9.554344	10.445656	10.026239	10.471895	17
44	9.528458	9.973716	9.554741	10.445259	10.026284	10.471542	16
45	9.528810	9.973671	9.555139	10.444861	10.026329	10.471190	15
46	9.529161	9.973625	9.555536	10.444464	10.026375	10.470839	14
47	9.529513	9.973580	9.555933	10.444067	10.026420	10.470487	13
48	9.529864	9.973535	9.556329	10.443671	10.026465	10.470136	12
49	9.530215	9.973489	9.556725	10.443275	10.026511	10.469785	11
50	9.530565	9.973443	9.557121	10.442879	10.026557	10.469435	10
51	9.530915	9.973398	9.557517	10.442483	10.026602	10.469085	9
52	9.531265	9.973352	9.557912	10.442088	10.026648	10.468735	8
53	9.531614	9.973307	9.558308	10.441692	10.026693	10.468386	7
54	9.531963	9.973261	9.558702	10.441298	10.026739	10.468037	6
55	9.532312	9.973215	9.559097	10.440903	10.026785	10.467688	5
56	9.532661	9.973169	9.559491	10.440509	10.026831	10.467339	4
57	9.533009	9.973124	9.559885	10.440115	10.026876	10.466991	3
58	9.533357	9.973078	9.560279	10.439721	10.026922	10.466643	2
59	9.533704	9.973032	9.560673	10.439327	10.026968	10.466296	1
60	9.534052	9.972986	9.561066	10.438934	10.027014	10.465948	0
		Sine		Tangent		Secant	Minutes

70 Degrees.

20 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.534052	9.972986	9.561066	10.438934	10.027014	10.465948	60
1	9.534399	9.972940	9.561459	10.438541	10.027060	10.465601	59
2	9.534745	9.972894	9.561851	10.438149	10.027106	10.465255	58
3	9.535092	9.972848	9.562244	10.437756	10.027152	10.464908	57
4	9.535437	9.972802	9.562636	10.437364	10.027198	10.464563	56
5	9.535783	9.972755	9.563028	10.436972	10.027245	10.464217	55
6	9.536129	9.972709	9.563419	10.436581	10.027291	10.463871	54
7	9.536474	9.972663	9.563811	10.436189	10.027337	10.463526	53
8	9.536818	9.972617	9.564202	10.435798	10.027383	10.463182	52
9	9.537163	9.972570	9.564592	10.435408	10.027430	10.462837	51
10	9.537507	9.972524	9.564983	10.435017	10.027476	10.462493	50
11	9.537851	9.972477	9.565373	10.434627	10.027523	10.462149	49
12	9.538194	9.972431	9.565763	10.434237	10.027569	10.461806	48
13	9.538538	9.972385	9.566153	10.433847	10.027615	10.461462	47
14	9.538880	9.972338	9.566542	10.433458	10.027662	10.461120	46
15	9.539223	9.972291	9.566932	10.433068	10.027709	10.460777	45
16	9.539565	9.972245	9.567321	10.432679	10.027755	10.460435	44
17	9.539907	9.972198	9.567709	10.432291	10.027802	10.460093	43
18	9.540249	9.972151	9.568098	10.431902	10.027849	10.459751	42
19	9.540590	9.972105	9.568486	10.431514	10.027895	10.459410	41
20	9.540931	9.972058	9.568873	10.431127	10.027942	10.459069	40
21	9.541272	9.972011	9.569261	10.430739	10.027989	10.458728	39
22	9.541613	9.971964	9.569648	10.430352	10.028036	10.458387	38
23	9.541953	9.971917	9.570035	10.429965	10.028083	10.458047	37
24	9.542293	9.971870	9.570422	10.429578	10.028130	10.457707	36
25	9.542632	9.971823	9.570809	10.429191	10.028177	10.457368	35
26	9.542971	9.971776	9.571195	10.428805	10.028224	10.457029	34
27	9.543310	9.971729	9.571581	10.428419	10.028271	10.456690	33
28	9.543649	9.971682	9.571967	10.428033	10.028318	10.456351	32
29	9.543987	9.971635	9.572352	10.427648	10.028365	10.456013	31
30	9.544325	9.971588	9.572738	10.427262	10.028412	10.455675	30
		Sine		Tangent		Secant	Minutes

69 Degrees.

20 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.544325	9.971588	9.572738	10.427262	10.028412	10.455675	30
31	9.544663	9.971540	9.573123	10.426877	10.028460	10.455337	29
32	9.545001	9.971493	9.573507	10.426493	10.028507	10.454999	28
33	9.545338	9.971446	9.573892	1 ..426108	10.028554	10.454662	27
34	9.545674	9.971398	9.574276	10.425724	10.028602	10.454326	26
35	9.546011	9.971351	9.574660	10.425340	10.028649	10.453989	25
36	9.546347	9.971303	9.575044	10.424956	10.028697	10.453653	24
37	9.546683	9.971256	9.575427	10.424573	10.028744	10.453317	23
38	9.547019	9.971208	9.575810	10.424190	10.028792	10.452981	22
39	9.547354	9.971161	9.576193	10.423807	10.028839	10.452646	21
40	9.547689	9.971113	9.576576	10.423424	10.028887	10.452311	20
41	9.548024	9.971065	9.576958	10.423042	10.028935	10.451976	19
42	9.548358	9.971018	9.577341	10.422659	10.028982	10.451642	18
43	9.548693	9.970970	9.577723	10.422277	10.029030	10.451307	17
44	9.549027	9.970922	9.578104	10.421896	10.029078	10.450973	16
45	9.549360	9.970874	9.578486	10.421514	10.029126	10.450640	15
46	9.549693	9.970826	9.578867	10.421133	10.029174	10.450307	14
47	9.550026	9.970779	9.579248	10.420752	10.029221	10.449974	13
48	9.550359	9.970731	9.579629	10.420371	10.029269	10.449641	12
49	9.550692	9.970683	9.580009	10.419991	10.029317	10.449308	11
50	9.551024	9.970635	9.580389	10.419611	10.029365	10.448976	10
51	9.551356	9.970586	9.580769	10.419231	10.029414	10.448644	9
52	9.551687	9.970538	9.581149	10.418851	10.029462	10.448313	8
53	9.552018	9.970490	9.581528	10.413472	10.029510	10.447982	7
54	9.552349	9.970442	9.581907	10.418093	10.029558	10.447651	6
55	9.552680	9.970394	9.582286	10.417714	10.029606	10.447320	5
56	9.553010	9.970345	9.582665	10.417335	10.029655	10.446990	4
57	9.553341	9.970297	9.583043	10.416957	10.029703	10.446659	3
58	9.553670	9.970249	9.583422	10.416578	10.029751	10.446330	2
59	9.554000	9.970200	9.583800	10.416200	10.029800	10.446000	1
60	9.554329	9.970152	9.584177	10.415823	10.029848	10.445671	0
		Sine		Tangent		Secant	Minutes

69 Degrees.

21 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.554329	9.970152	9.584177	10.415823	10.029848	10.445671	60
1	9.554658	9.970103	9.584555	10.415445	10.029897	10.445342	59
2	9.554987	9.970055	9.584932	10.415068	10.029945	10.445013	58
3	9.555315	9.970006	9.585309	10.414691	10.029994	10.444685	57
4	9.555643	9.969957	9.585686	10.414314	10.030043	10.444357	56
5	9.555971	9.969909	9.586062	10.413938	10.030091	10.444029	55
6	9.556299	9.969860	9.586439	10.413561	10.030140	10.443701	54
7	9.556626	9.969811	9.586815	10.413185	10.030189	10.443374	53
8	9.556953	9.969762	9.587190	10.412810	10.030238	10.443047	52
9	9.557280	9.969714	9.587566	10.412434	10.030286	10.442720	51
10	9.557606	9.969665	9.587941	10.412059	10.030335	10.442394	50
11	9.557932	9.969616	9.588316	10.411684	10.030384	10.442068	49
12	9.558258	9.969567	9.588691	10.411309	10.030433	10.441742	48
13	9.558583	9.969518	9.589066	10.410934	10.030482	10.441417	47
14	9.558909	9.969469	9.589440	10.410560	10.030531	10.441091	46
15	9.559234	9.969420	9.589814	10.410186	10.030580	10.440766	45
16	9.559558	9.969370	9.590188	10.409812	10.030630	10.440442	44
17	9.559883	9.969321	9.590562	10.409438	10.030679	10.440117	43
18	9.560207	9.969272	9.590935	10.409065	10.030728	10.439793	42
19	9.560531	9.969223	9.591308	10.408692	10.030777	10.439469	41
20	9.560855	9.969173	9.591681	10.408319	10.030827	10.439145	40
21	9.561178	9.969124	9.592054	10.407946	10.030876	10.438822	39
22	9.561501	9.969075	9.592426	10.407574	10.030925	10.438499	38
23	9.561824	9.969025	9.592798	10.407202	10.030975	10.438176	37
24	9.562146	9.968976	9.593170	10.406830	10.031024	10.437854	36
25	9.562468	9.968926	9.593542	10.406458	10.031074	10.437532	35
26	9.562790	9.968877	9.593914	10.406086	10.031123	10.437210	34
27	9.563112	9.968827	9.594285	10.405715	10.031173	10.436888	33
28	9.563434	9.968777	9.594656	10.405344	10.031223	10.436566	32
29	9.563755	9.968728	9.595027	10.404973	10.031272	10.436245	31
30	9.564075	9.968678	9.595397	10.404603	10.031322	10.435925	30
		Sine		Tangent		Secant	Minutes

68 Degrees.

21 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.564075	9.968678	9.595397	10.404603	10.031322	10.435925	30
1	9.564396	9.968628	9.595768	10.404232	10.031372	10.435604	29
2	9.564716	9.968578	9.596138	10.403862	10.031422	10.435284	28
3	9.565036	9.968528	9.596508	10.403492	10.031472	10.434964	27
4	9.565356	9.968479	9.596878	10.403122	10.031521	10.434644	26
5	9.565676	9.968429	9.597247	10.402753	10.031571	10.434324	25
6	9.565995	9.968379	9.597616	10.402384	10.031621	10.434005	24
7	9.566314	9.968328	9.597985	10.402015	10.031672	10.433686	23
8	9.566632	9.968278	9.598354	10.401646	10.031722	10.433368	22
9	9.566951	9.968228	9.598722	10.401278	10.031772	10.433049	21
0	9.567269	9.968178	9.599091	10.400909	10.031822	10.432731	20
1	9.567587	9.968128	9.599459	10.400541	10.031872	10.432413	19
2	9.567904	9.968078	9.599827	10.400173	10.031922	10.432096	18
3	9.568222	9.968027	9.600194	10.399806	10.031973	10.431778	17
4	9.568539	9.967977	9.600562	10.399438	10.032023	10.431461	16
5	9.568855	9.967927	9.600929	10.399071	10.032073	10.431145	15
6	9.569172	9.967876	9.601296	10.398704	10.032124	10.430828	14
7	9.569488	9.967826	9.601662	10.398338	10.032174	10.430512	13
8	9.569804	9.967775	9.602029	10.397971	10.032225	10.430196	12
9	9.570120	9.967725	9.602395	10.397605	10.032275	10.429880	11
0	9.570435	9.967674	9.602761	10.397239	10.032326	10.439565	10
1	9.570751	9.967623	9.603127	10.396873	10.032377	10.429249	9
2	9.571066	9.967573	9.603493	10.396507	10.032427	10.428934	8
3	9.571380	9.967522	9.603858	10.396142	10.032478	10.428620	7
4	9.571695	9.967471	9.604223	10.395777	10.032529	10.428305	6
5	9.572009	9.967420	9.604588	10.395412	10.032580	10.427991	5
6	9.572323	9.967370	9.604953	10.395047	10.032630	10.427677	4
7	9.572636	9.967319	9.605317	10.394683	10.032681	10.427364	3
8	9.572949	9.967268	9.605682	10.394318	10.032732	10.427051	2
9	9.573263	9.967217	9.606046	10.393954	10.032783	10.426737	1
60	9.573575	9.967166	9.606410	10.393590	10.032834	10.426425	0
		Sine		Tangent		Secant	Minutes

68 Degrees.

22 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.573575	9.967166	9.606410	10.393590	10.032834	10.426425	60
1	9.573888	9.967115	9.606773	10.393227	10.032885	10.426112	59
2	9.574200	9.967064	9.607137	10.392863	10.032936	10.425800	58
3	9.574512	9.967013	9.607500	10.392500	10.032987	10.425488	57
4	9.574824	9.966961	9.607863	10.392137	10.033039	10.425176	56
5	9.575136	9.966910	9.608225	10.391775	10.033090	10.424864	55
6	9.575447	9.966859	9.608588	10.391412	10.033141	10.424553	54
7	9.575758	9.966807	9.608950	10.391050	10.033193	10.424242	53
8	9.576068	9.966756	9.609312	10.390688	10.033244	10.423932	52
9	9.576379	9.966705	9.609674	10.390326	10.033295	10.423621	51
10	9.576689	9.966653	9.610036	10.389964	10.033347	10.423311	50
11	9.576999	9.966602	9.610397	10.389603	10.033398	10.423001	49
12	9.577309	9.966550	9.610759	10.389241	10.033450	10.422691	48
13	9.577618	9.966499	9.611120	10.388880	10.033501	10.422382	47
14	9.577927	9.966447	9.611480	10.388520	10.033553	10.422073	46
15	9.578236	9.966395	9.611841	10.388159	10.033605	10.421764	45
16	9.578545	9.966344	9.612201	10.387799	10.033656	10.421455	44
17	9.578854	9.966292	9.612561	10.387439	10.033708	10.421146	43
18	9.579162	9.966240	9.612921	10.387079	10.033760	10.420838	42
19	9.579469	9.966188	9.613281	10.386719	10.033812	10.420531	41
20	9.579777	9.966137	9.613641	10.386359	10.033863	10.420223	40
21	9.580085	9.966085	9.614000	10.386000	10.033915	10.419915	39
22	9.580392	9.966033	9.614359	10.385641	10.033967	10.419608	38
23	9.580699	9.965981	9.614718	10.385282	10.034019	10.419301	37
24	9.581005	9.965928	9.615077	10.384923	10.034072	10.418995	36
25	9.581312	9.965876	9.615435	10.384565	10.034124	10.418688	35
26	9.581618	9.965824	9.615793	10.384207	10.034176	10.418382	34
27	9.581924	9.965772	9.616151	10.383849	10.034228	10.418076	33
28	9.582229	9.965720	9.616509	10.383491	10.034280	10.417771	32
29	9.582535	9.965668	9.616867	10.383133	10.034332	10.417465	31
30	9.582840	9.965615	9.617224	10.382776	10.034385	10.417160	30
		Sine		Tangent		Secant	Minutes

67 Degrees.

22 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.582840	9.965615	9.617224	10.382776	10.034385	10.417160	30
31	9.583145	9.965563	9.617582	10.382418	10.034437	10.416855	29
32	9.583449	9.965511	9.617939	10.382061	10.034489	10.416551	28
33	9.583754	9.965458	9.618295	10.381705	10.034542	10.416240	27
34	9.584058	9.965406	9.618652	10.381348	10.034594	10.415942	26
35	9.584361	9.965353	9.619008	10.380992	10.034647	10.415639	25
36	9.584665	9.965301	9.619365	10.380635	10.034699	10.415335	24
37	9.584968	9.965240	9.619721	10.380279	10.034752	10.415032	23
38	9.585272	9.965195	9.620076	10.379924	10.034705	10.414728	22
39	9.585574	9.965143	9.620432	10.379568	10.034857	10.414426	21
40	9.585877	9.965090	9.620787	10.379213	10.034910	10.414123	20
41	9.586180	9.965037	9.621142	10.378858	10.034963	10.413820	19
42	9.586482	9.964984	9.621497	10.378503	10.035016	10.413518	18
43	9.586784	9.964931	9.621852	10.378148	10.035069	10.413216	17
44	9.587085	9.964879	9.622207	10.377793	10.035121	10.412915	16
45	9.587386	9.964826	9.622561	10.377439	10.035174	10.412614	15
46	9.587688	9.964773	9.622915	10.377085	10.035227	10.412312	14
47	9.587988	9.964719	9.623269	10.376731	10.035281	10.412012	13
48	9.588289	9.964666	9.623623	10.376377	10.035334	10.411711	12
49	9.588590	9.964613	9.623976	10.376024	10.035387	10.411410	11
50	9.588890	9.964560	9.624330	10.375670	10.035440	10.411110	10
51	9.589190	9.964507	9.624683	10.375317	10.035493	10.410810	9
52	9.589489	9.964454	9.625036	10.374964	10.035546	10.410511	8
53	9.589789	9.964400	9.625388	10.374612	10.035600	10.410211	7
54	9.590088	9.964347	9.625741	10.374259	10.035653	10.409912	6
55	9.590387	9.964294	9.626093	10.373907	10.035706	10.409613	5
56	9.590686	9.964240	9.626445	10.373555	10.035760	10.409314	4
57	9.590984	9.964187	9.626797	10.373203	10.035813	10.409016	3
58	9.591282	9.964133	9.627149	10.372851	10.035867	10.408718	2
59	9.591580	9.964080	9.627501	10.372499	10.035920	10.408420	1
60	9.591878	9.964026	9.627852	10.372148	10.035974	10.408122	
		Sine		Tangent		Secant	Minutes

67 Degrees.

23 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.591878	9.964026	9.627852	10.372148	10.035974	10.408122	60
1	9.592175	9.963972	9.628203	10.371797	10.036028	10.407825	59
2	9.592473	9.963919	9.628554	10.371446	10.036081	10.407527	58
3	9.592770	9.963865	9.628905	10.371095	10.036135	10.407230	57
4	9.593067	9.963811	9.629255	10.370745	10.036189	10.406933	56
5	9.593363	9.963757	9.629606	10.370394	10.036243	10.406637	55
6	9.593659	9.963704	9.629956	10.370044	10.036296	10.406341	54
7	9.593955	9.963650	9.630306	10.369694	10.036350	10.406045	53
8	9.594251	9.963596	9.630656	10.369344	10.036404	10.405749	52
9	9.594547	9.963542	9.631005	10.368995	10.036458	10.405453	51
10	9.594842	9.963488	9.631354	10.368646	10.036512	10.405158	50
11	9.595137	9.963434	9.631704	10.368296	10.036566	10.404863	49
12	9.595432	9.963379	9.632053	10.367947	10.036621	10.404568	48
13	9.595727	9.963325	9.632401	10.367599	10.036675	10.404273	47
14	9.596021	9.963271	9.632750	10.367250	10.036729	10.403979	46
15	9.596315	9.963217	9.633098	10.366902	10.036783	10.403685	45
16	9.596609	9.963162	9.633447	10.366553	10.036838	10.403391	44
17	9.596903	9.963108	9.633795	10.366205	10.036892	10.403097	43
18	9.597196	9.963054	9.634143	10.365857	10.036946	10.402804	42
19	9.597490	9.962999	9.634490	10.365510	10.037001	10.402510	41
20	9.597783	9.962945	9.634838	10.365162	10.037055	10.402217	40
21	9.598075	9.962890	9.635185	10.364815	10.037110	10.401925	39
22	9.598368	9.962836	9.635532	10.364468	10.037164	10.401632	38
23	9.598660	9.962781	9.635879	10.364121	10.037219	10.401340	37
24	9.598952	9.962727	9.636226	10.363774	10.037273	10.401048	36
25	9.599244	9.962672	9.636572	10.363428	10.037328	10.400756	35
26	9.599536	9.962617	9.636918	10.363082	10.037383	10.400464	34
27	9.599827	9.962562	9.637265	10.362735	10.037438	10.400173	33
28	9.600118	9.962508	9.637611	10.362389	10.037492	10.399882	32
29	9.600409	9.962453	9.637956	10.362044	10.037547	10.399591	31
30	9.600700	9.962398	9.638302	10.361698	10.037602	10.399300	30
		Sine		Tangent		Secant	Minutes

66 Degrees.

23 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.600700	9.962398	9.638302	10.361698	10.037602	10.399300	30
31	9.600990	9.962343	9.638647	10.361353	10.037657	10.399010	29
32	9.601280	9.962288	9.638992	10.361008	10.037712	10.398720	28
33	9.601570	9.962233	9.639337	10.360663	10.037767	10.398430	27
34	9.601860	9.962178	9.639682	10.360318	10.037822	10.398140	26
35	9.602149	9.962123	9.640027	10.359973	10.037877	10.397851	25
36	9.602439	9.962067	9.640371	10.359629	10.037933	10.397561	24
37	9.602728	9.962012	9.640716	10.359284	10.037988	10.397272	23
38	9.603017	9.961957	9.641060	10.358940	10.038043	10.396983	22
39	9.603305	9.961902	9.641404	10.358596	10.038098	10.396695	21
40	9.603594	9.961846	9.641747	10.358253	10.038154	10.396406	20
41	9.603882	9.961791	9.642091	10.357909	10.038209	10.396118	19
42	9.604170	9.961735	9.642434	10.357566	10.038265	10.395830	18
43	9.604457	9.961680	9.642777	10.357223	10.038320	10.395543	17
44	9.604745	9.961624	9.643120	10.356880	10.038376	10.395255	16
45	9.605032	9.961569	9.643463	10.356537	10.038431	10.394968	15
46	9.605319	9.961513	9.643806	10.356194	10.038487	10.394681	14
47	9.605606	9.961458	9.644148	10.355852	10.038542	10.394394	13
48	9.605892	9.961402	9.644490	10.355510	10.038598	10.394108	12
49	9.606179	9.961346	9.644832	10.355168	10.038654	10.393821	11
50	9.606465	9.961290	9.645174	10.354826	10.038710	10.393535	10
51	9.606751	9.961235	9.645516	10.354484	10.038765	10.393249	9
52	9.607036	9.961179	9.645857	10.354143	10.038821	10.392964	8
53	9.607322	9.961123	9.646199	10.353801	10.038877	10.392678	7
54	9.607607	9.961067	9.646540	10.353460	10.038933	10.392393	6
55	9.607892	9.961011	9.646881	10.353119	10.038989	10.392108	5
56	9.608176	9.960955	9.647222	10.352778	10.039045	10.391824	4
57	9.608461	9.960899	9.647562	10.352438	10.039101	10.391539	3
58	9.608745	9.960843	9.647903	10.352097	10.039157	10.391255	2
59	9.609029	9.960786	9.648243	10.351757	10.039214	10.390971	1
60	9.609313	9.960730	9.648583	10.351417	10.039270	10.390687	0
		Sine		Tangent		Secant	Minutes

66 Degrees.

24 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.609313	9.960730	9.648583	10.351417	10.039270	10.390687	60
1	9.609597	9.960674	9.648923	10.351077	10.039326	10.390403	59
2	9.609880	9.960618	9.649263	10.350737	10.039382	10.390120	58
3	9.610163	9.960561	9.649602	10.350398	10.039439	10.389837	57
4	9.610446	9.960505	9.649942	10.350058	10.039495	10.389554	56
5	9.610729	9.960448	9.650281	10.349719	10.039552	10.389271	55
6	9.611012	9.960392	9.650620	10.349380	10.039608	10.388988	54
7	9.611294	9.960335	9.650959	10.349041	10.039665	10.388706	53
8	9.611576	9.960279	9.651297	10.348703	10.039721	10.388424	52
9	9.611858	9.960222	9.651636	10.348364	10.039778	10.388142	51
10	9.612140	9.960166	9.651974	10.348026	10.039834	10.387860	50
11	9.612421	9.960109	9.652312	10.347688	10.039891	10.387579	49
12	9.612702	9.960052	9.652650	10.347350	10.039948	10.387298	48
13	9.612983	9.959995	9.652988	10.347012	10.040005	10.387017	47
14	9.613264	9.959938	9.653326	10.346674	10.040062	10.386736	46
15	9.613545	9.959882	9.653663	10.346337	10.040118	10.386455	45
16	9.613825	9.959825	9.654000	10.346000	10.040175	10.386175	44
17	9.614105	9.959768	9.654337	10.345663	10.040232	10.385895	43
18	9.614385	9.959711	9.654674	10.345326	10.040289	10.385615	42
19	9.614665	9.959653	9.655011	10.344989	10.040347	10.385335	41
20	9.614944	9.959596	9.655348	10.344652	10.040404	10.385056	40
21	9.615223	9.959539	9.655684	10.344316	10.040461	10.384777	39
22	9.615502	9.959482	9.656020	10.343980	10.040518	10.384498	38
23	9.615781	9.959425	9.656356	10.343644	10.040575	10.384219	37
24	9.616060	9.959368	9.656692	10.343308	10.040632	10.383940	36
25	9.616338	9.959310	9.657028	10.342972	10.040690	10.383662	35
26	9.616616	9.959253	9.657364	10.342636	10.040747	10.383384	34
27	9.616894	9.959195	9.657699	10.342301	10.040805	10.383106	33
28	9.617172	9.959138	9.658034	10.341966	10.040862	10.382828	32
29	9.617450	9.959081	9.658369	10.341631	10.040919	10.382550	31
30	9.617727	9.959023	9.658704	10.341296	10.040977	10.382273	30
		Sine		Tangent		Secant	Minutes

65 Degrees.

24 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.617727	9.959023	9.658704	10.341290	10.040977	10.382273	30
31	9.618004	9.958965	9.659039	10.340961	10.041035	10.381996	29
32	9.618281	9.958908	9.659373	10.340627	10.041092	10.381719	28
33	9.618558	9.958850	9.659708	10.340292	10.041150	10.381442	27
34	9.618834	9.958792	9.660042	10.339958	10.041208	10.381166	26
35	9.619110	9.958734	9.660376	10.339624	10.041266	10.380890	25
36	9.619386	9.958677	9.660710	10.339290	10.041323	10.380614	24
37	9.619662	9.958619	9.661043	10.338957	10.041381	10.380338	23
38	9.619938	9.958561	9.661377	10.338623	10.041439	10.380062	22
39	9.620213	9.958503	9.661710	10.338290	10.041497	10.379787	21
40	9.620488	9.958445	9.662043	10.337957	10.041555	10.379512	20
41	9.620763	9.958387	9.662376	10.337624	10.041613	10.379237	19
42	9.621038	9.958329	9.662709	10.337291	10.041671	10.378962	18
43	9.621313	9.958271	9.663042	10.336958	10.041729	10.378687	17
44	9.621587	9.958212	9.663375	10.336625	10.041788	10.378413	16
45	9.621861	9.958154	9.663707	10.336293	10.041846	10.378139	15
46	9.622135	9.958096	9.664039	10.335961	10.041904	10.377865	14
47	9.622409	9.958038	9.664371	10.335629	10.041962	10.377591	13
48	9.622682	9.957979	9.664703	10.335297	10.042021	10.377318	12
49	9.622956	9.957921	9.665035	10.334965	10.042079	10.377044	11
50	9.623229	9.957863	9.665366	10.334634	10.042137	10.376771	10
51	9.623502	9.957804	9.665697	10.334303	10.042196	10.376498	9
52	9.623774	9.957746	9.666029	10.333971	10.042254	10.376226	8
53	9.624047	9.957687	9.666360	10.333640	10.042313	10.375953	7
54	9.624319	9.957628	9.666691	10.333309	10.042372	10.375681	6
55	9.624591	9.957570	9.667021	10.332979	10.042430	10.375409	5
56	9.624863	9.957511	9.667352	10.332648	10.042489	10.375137	4
57	9.625135	9.957452	9.667682	10.332318	10.042548	10.374865	3
58	9.625406	9.957393	9.668013	10.331987	10.042607	10.374594	2
59	9.625677	9.957335	9.668343	10.331657	10.042665	10.374323	1
60	9.625948	9.957276	9.668672	10.331328	10.042724	10.374052	0
		Sine		Tangent		Secant	Minutes

65 Degrees.

25 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.625948	9.957276	9.668672	10.331328	10.042724	10.374052	60
1	9.626219	9.957217	9.669002	10.330998	10.042783	10.373781	59
2	9.626490	9.957158	9.669332	10.330668	10.042842	10.373510	58
3	9.626760	9.957099	9.669661	10.330339	10.042901	10.373240	57
4	9.627030	9.957040	9.669991	10.330009	10.042960	10.372970	56
5	9.627300	9.956981	9.670320	10.329680	10.043019	10.372700	55
6	9.627570	9.956922	9.670649	10.329351	10.043078	10.372430	54
7	9.627840	9.956862	9.670977	10.329023	10.043138	10.372160	53
8	9.628109	9.956803	9.671306	10.328694	10.043197	10.371891	52
9	9.628378	9.956744	9.671634	10.328366	10.043256	10.371622	51
10	9.628647	9.956684	9.671963	10.328037	10.043316	10.371353	50
11	9.628916	9.956625	9.672291	10.327709	10.043375	10.371084	49
12	9.629184	9.956566	9.672619	10.327381	10.043434	10.370816	48
13	9.629453	9.956506	9.672947	10.327053	10.043494	10.370547	47
14	9.629721	9.956447	9.673274	10.326726	10.043553	10.370279	46
15	9.629989	9.956387	9.673602	10.326398	10.043613	10.370011	45
16	9.630257	9.956327	9.673929	10.326071	10.043673	10.369743	44
17	9.630524	9.956268	9.674257	10.325743	10.043732	10.369476	43
18	9.630792	9.956208	9.674584	10.325416	10.043792	10.369208	42
19	9.631059	9.956148	9.674910	10.325090	10.043852	10.368941	41
20	9.631326	9.956089	9.675237	10.324763	10.043911	10.368674	40
21	9.631593	9.956029	9.675564	10.324436	10.043971	10.368407	39
22	9.631859	9.955969	9.675890	10.324110	10.044031	10.368141	38
23	9.632126	9.955909	9.676216	10.323784	10.044091	10.367874	37
24	9.632392	9.955849	9.676543	10.323457	10.044151	10.367608	36
25	9.632658	9.955789	9.676869	10.323131	10.044211	10.367342	35
26	9.632923	9.955729	9.677194	10.322806	10.044271	10.367077	34
27	9.633189	9.955669	9.677520	10.322480	10.044331	10.366811	33
28	9.633454	9.955609	9.677846	10.322154	10.044391	10.366546	32
29	9.633719	9.955548	9.678171	10.321829	10.044452	10.366281	31
30	9.633984	9.955488	9.678496	10.321504	10.044512	10.366016	30
		Sine		Tangent		Secant	Minutes

64 Degrees.

25 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.633984	9.955488	9.678496	10.321504	10.044512	10.366016	30
31	9.634249	9.955428	9.678821	10.321179	10.044572	10.365751	29
32	9.634514	9.955368	9.679146	10.320854	10.044632	10.365486	28
33	9.634778	9.955307	9.679471	10.320529	10.044693	10.365222	27
34	9.635042	9.955247	9.679795	10.320205	10.044753	10.364958	26
35	9.635306	9.955186	9.680120	10.319880	10.044814	10.364694	25
36	9.635570	9.955126	9.680444	10.319556	10.044874	10.364430	24
37	9.635833	9.955065	9.680768	10.319232	10.044935	10.364167	23
38	9.636097	9.955005	9.681092	10.318908	10.044995	10.363903	22
39	9.636360	9.954944	9.681416	10.318584	10.045056	10.363640	21
40	9.636623	9.954883	9.681740	10.318260	10.045117	10.363377	20
41	9.636886	9.954823	9.682063	10.317937	10.045177	10.363114	19
42	9.637148	9.954762	9.682386	10.317614	10.045238	10.362852	18
43	9.637411	9.954701	9.682710	10.317290	10.045299	10.362589	17
44	9.637673	9.954640	9.683033	10.316967	10.045360	10.362327	16
45	9.637935	9.954579	9.683356	10.316644	10.045421	10.362065	15
46	9.638197	9.954518	9.683678	10.316322	10.045482	10.361803	14
47	9.638458	9.954457	9.684001	10.315999	10.045543	10.361542	13
48	9.638720	9.954396	9.684324	10.315676	10.045604	10.361280	12
49	9.638981	9.954335	9.684646	10.315354	10.045665	10.361019	11
50	9.639242	9.954274	9.684968	10.315032	10.045726	10.360758	10
51	9.639503	9.954213	9.685290	10.314710	10.045787	10.360497	9
52	9.639764	9.954152	9.685612	10.314388	10.045848	10.360236	8
53	9.640024	9.954090	9.685934	10.314066	10.045910	10.359976	7
54	9.640284	9.954029	9.686255	10.313745	10.045971	10.359716	6
55	9.640544	9.953968	9.686577	10.313423	10.046032	10.359456	5
56	9.640804	9.953906	9.686898	10.313102	10.046094	10.359196	4
57	9.641064	9.953845	9.687219	10.312781	10.046155	10.358936	3
58	9.641323	9.953783	9.687540	10.312460	10.046217	10.358677	2
59	9.641583	9.953722	9.687861	10.312139	10.046278	10.358417	1
60	9.641842	9.953660	9.688182	10.311818	10.046340	10.358158	0
		Sine		Tangent		Secant	Minutes

64 Degrees.

26 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.641842	9.953660	9.688182	10.311818	10.046340	10.358158	00
1	9.642101	9.953598	9.688502	10.311498	10.046402	10.357899	59
2	9.642360	9.953537	9.688823	10.311177	10.046463	10.357640	58
3	9.642618	9.953475	9.689143	10.310857	10.046525	10.357382	57
4	9.642876	9.953413	9.689463	10.310537	10.046587	10.357124	56
5	9.643135	9.953352	9.689783	10.310217	10.046648	10.356865	55
6	9.643393	9.953290	9.690103	10.309897	10.046710	10.356607	54
7	9.643650	9.953228	9.690423	10.309577	10.046772	10.356350	53
8	9.643908	9.953166	9.690742	10.309258	10.046834	10.356092	52
9	9.644165	9.953104	9.691062	10.308938	10.046896	10.355835	51
10	9.644423	9.953042	9.691381	10.308619	10.046958	10.355577	50
11	9.644680	9.952980	9.691700	10.308300	10.047020	10.355320	49
12	9.644937	9.952917	9.692019	10.307981	10.047083	10.355063	48
13	9.645193	9.952855	9.692338	10.307662	10.047145	10.354807	47
14	9.645450	9.952793	9.692657	10.307343	10.047207	10.354550	46
15	9.645706	9.952731	9.692975	10.307025	10.047269	10.354294	45
16	9.645962	9.952669	9.693293	10.306707	10.047331	10.354038	44
17	9.646218	9.952606	9.693612	10.306388	10.047394	10.353782	43
18	9.646474	9.952544	9.693930	10.306070	10.047456	10.353526	42
19	9.646729	9.952481	9.694248	10.305752	10.047519	10.353271	41
20	9.646984	9.952419	9.694566	10.305434	10.047581	10.353016	40
21	9.647239	9.952356	9.694883	10.305117	10.047644	10.352761	39
22	9.647495	9.952294	9.695201	10.304799	10.047706	10.352505	38
23	9.647749	9.952231	9.695518	10.304482	10.047769	10.352251	37
24	9.648004	9.952168	9.695836	10.304164	10.047832	10.351996	36
25	9.648258	9.952105	9.696153	10.303847	10.047895	10.351742	35
26	9.648512	9.952043	9.696470	10.303530	10.047957	10.351488	34
27	9.648766	9.951980	9.696787	10.303213	10.048020	10.351234	33
28	9.649020	9.951917	9.697103	10.302897	10.048083	10.350980	32
29	9.649274	9.951854	9.697420	10.302580	10.048146	10.350726	31
30	9.649527	9.951791	9.697736	10.302264	10.048209	10.350473	30
		Sine		Tangent		Secant	Minutes

63 Degrees.

26 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.649527	9.951791	9.697736	10.302264	10.048209	10.350473	30
31	9.649781	9.951728	9.698053	10.301947	10.048272	10.350219	29
32	9.650034	9.951665	9.698369	10.301631	10.048335	10.349966	28
33	9.650287	9.951602	9.698685	10.301315	10.048398	10.349713	27
34	9.650539	9.951539	9.699001	10.300999	10.048461	10.349461	26
35	9.650792	9.951476	9.699316	10.300684	10.048524	10.349208	25
36	9.651044	9.951412	9.6996[illegible]	10.300368	10.048588	10.348956	24
37	9.651297	9.951349	9.6999[illegible]7	10.300053	10.048651	10.348703	23
38	9.651549	9.951286	9.7002[illegible]3	10.299737	10.048714	10.348451	22
39	9.651800	9.951222	9.700578	10.299422	10.048778	10.348200	21
40	9.652052	9.951159	9.700893	10.299107	10.048841	10.347948	20
41	9.652304	9.951096	9.701208	10.298792	10.048904	10.347696	19
42	9.652555	9.951032	9.701523	10.298477	10.048968	10.347445	18
43	9.652806	9.950968	9.701837	10.298163	10.049032	10.347194	17
44	9.653057	9.950905	9.702152	10.297848	10.049095	10.346943	16
45	9.653307	9.950841	9.702466	10.297534	10.049159	10.346693	15
46	9.653558	9.950778	9.702780	10.297220	10.049222	10.346442	14
47	9.653808	9.950714	9.703095	10.296905	10.049286	10.346192	13
48	9.654059	9.950650	9.703409	10.296591	10.049350	10.345941	12
49	9.654309	9.950586	9.703723	10.296277	10.049414	10.345691	11
50	9.654558	9.950522	9.704036	10.295964	10.049478	10.345442	10
51	9.654808	9.950458	9.704350	10.295650	10.049542	10.345192	9
52	9.655057	9.950394	9.704663	10.295337	10.049606	10.344943	8
53	9.655307	9.950330	9.704977	10.295023	10.049670	10.344693	7
54	9.655556	9.950266	9.705290	10.294710	10.049734	10.344444	6
55	9.655805	9.950202	9.705603	10.294397	10.049798	10.344195	5
56	9.656054	9.950138	9.705916	10.294084	10.049862	10.343946	4
57	9.656302	9.950074	9.706228	10.293772	10.049926	10.343698	3
58	9.656551	9.950009	9.706541	10.293459	10.049991	10.343449	2
59	9.656799	9.949945	9.706854	10.293146	10.050055	10.343201	1
60	9.657047	9.949881	9.707166	10.292834	10.050119	10.342953	0
		Sine		Tangent		Secant	Minutes

63 Degrees.

27 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.657047	9.949881	9.707166	10.292834	10.050119	10.342953	60
1	9.657295	9.949816	9.707478	10.292522	10.050184	10.342705	59
2	9.657542	9.949752	9.707790	10.292210	10.050248	10.342458	58
3	9.657790	9.949688	9.708102	10.291898	10.050312	10.342210	57
4	9.658037	9.949623	9.708414	10.291586	10.050377	10.341963	56
5	9.658284	9.949558	9.708726	10.291274	10.050442	10.341716	55
6	9.658531	9.949494	9.709037	10.290963	10.050506	10.341469	54
7	9.658778	9.949429	9.709349	10.290651	10.050571	10.341222	53
8	9.659025	9.949364	9.709660	10.290340	10.050636	10.340975	52
9	9.659271	9.949300	9.709971	10.290029	10.050700	10.340729	51
10	9.659517	9.949235	9.710282	10.289718	10.050765	10.340483	50
11	9.659763	9.949170	9.710593	10.289407	10.050830	10.340237	49
12	9.660009	9.949105	9.710904	10.289096	10.050895	10.339991	48
13	9.660255	9.949040	9.711215	10.288785	10.050960	10.339745	47
14	9.660500	9.948975	9.711525	10.288475	10.051025	10.339500	46
15	9.660746	9.948910	9.711836	10.288164	10.051090	10.339254	45
16	9.660991	9.948845	9.712146	10.287854	10.051155	10.339009	44
17	9.661236	9.948780	9.712456	10.287544	10.051220	10.338764	43
18	9.661481	9.948715	9.712766	10.287234	10.051285	10.338519	42
19	9.661726	9.948649	9.713076	10.286924	10.051351	10.338274	41
20	9.661970	9.948584	9.713386	10.286614	10.051416	10.338030	40
21	9.662214	9.948519	9.713696	10.286304	10.051481	10.337786	39
22	9.662459	9.948453	9.714005	10.285995	10.051547	10.337541	38
23	9.662703	9.948388	9.714314	10.285686	10.051612	10.337297	37
24	9.662946	9.948323	9.714624	10.285376	10.051677	10.337054	36
25	9.663190	9.948257	9.714933	10.285067	10.051743	10.336810	35
26	9.663433	9.948192	9.715242	10.284758	10.051808	10.336567	34
27	9.663677	9.948126	9.715551	10.284449	10.051874	10.336323	33
28	9.663920	9.948060	9.715859	10.284141	10.051940	10.336080	32
29	9.664163	9.947995	9.716168	10.283832	10.052005	10.335837	31
30	9.664406	9.947929	9.716477	10.283523	10.052071	10.335594	30
		Sine		Tangent		Secant	Minutes

62 Degrees.

27 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.664406	9.947929	9.716477	10.283523	10.052071	10.335594	30
31	9.664648	9.947863	9.716785	10.283215	10.052137	10.335352	29
32	9.664891	9.947797	9.717093	10.282907	10.052203	10.335109	28
33	9.665133	9.947731	9.717401	10.282599	10.052269	10.334867	27
34	9.665375	9.947665	9.717709	10.282291	10.052335	10.334625	26
35	9.665617	9.947599	9.718017	10.281983	10.052401	10.334383	25
36	9.665859	9.947533	9.718325	10.281675	10.052467	10.334141	24
37	9.666100	9.947467	9.718633	10.281367	10.052533	10.333900	23
38	9.666341	9.947401	9.718940	10.281060	10.052599	10.333659	22
39	9.666583	9.947335	9.719248	10.280752	10.052665	10.333417	21
40	9.666824	9.947269	9.719555	10.280445	10.052731	10.333176	20
41	9.667065	9.947203	9.719862	10.280138	10.052797	10.332935	19
42	9.667305	9.947136	9.720169	10.279831	10.052864	10.332695	18
43	9.667546	9.947070	9.720476	10.279524	10.052930	10.332454	17
44	9.667786	9.947004	9.720783	10.279217	10.052996	10.332214	16
45	9.668026	9.946937	9.721089	10.278911	10.053063	10.331974	15
46	9.668266	9.946871	9.721396	10.278604	10.053129	10.331734	14
47	9.668506	9.946804	9.721702	10.278298	10.053196	10.331494	13
48	9.668746	9.946738	9.722008	10.277992	10.053262	10.331254	12
49	9.668986	9.946671	9.722315	10.277685	10.053329	10.331014	11
50	9.669225	9.9466[illegible]	9.722621	10.277379	10.053396	10.330775	10
51	9.669464	9.946538	9.722927	10.277073	10.053462	10.330536	9
52	9.669703	9.946471	9.723232	10.276768	10.053529	10.330297	8
53	9.669942	9.946404	9.723538	10.276462	10.053596	10.330058	7
54	9.670181	9.946337	9.723844	10.276156	10.053663	10.329819	6
55	9.670419	9.946270	9.724149	10.275851	10.053730	10.329581	5
56	9.670658	9.946203	9.724454	10.275546	10.053797	10.329342	4
57	9.670896	9.946136	9.724759	10.275241	10.053864	10.329104	3
58	9.671134	9.946069	9.725065	10.274935	10.053931	10.328866	2
59	9.671372	9.946002	9.725369	10.274631	10.053998	10.328628	1
60	9.671609	9.945935	9.725674	10.274326	10.054065	10.328391	0
		Sine		Tangent		Secant	Minutes

62 Degrees.

28 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.671609	9.945935	9.725674	10.274326	10.054065	10.328391	60
1	9.671847	9.945868	9.725979	10.274021	10.054132	10.328153	59
2	9.672084	9.945801	9.726284	10.273716	10.054199	10.327916	58
3	9.672321	9.945733	9.726588	10.273412	10.054267	10.327679	57
4	9.672558	9.945666	9.726893	10.273107	10.054334	10.327442	56
5	9.672795	9.945598	9.727197	10.272803	10.054402	10.327205	55
6	9.673032	9.945531	9.727501	10.272499	10.054469	10.326968	54
7	9.673268	9.945464	9.727805	10.272195	10.054536	10.326732	53
8	9.673505	9.945396	9.728109	10.271891	10.054604	10.326495	52
9	9.673741	9.945328	9.728412	10.271588	10.054672	10.326259	51
10	9.673977	9.945261	9.728716	10.271284	10.054739	10.326023	50
11	9.674213	9.945193	9.729020	10.270980	10.054807	10.325787	49
12	9.674448	9.945126	9.729323	10.270677	10.054874	10.325552	48
13	9.674684	9.945058	9.729626	10.270374	10.054942	10.325316	47
14	9.674919	9.944990	9.729929	10.270071	10.055010	10.325081	46
15	9.675155	9.944922	9.730233	10.269767	10.055078	10.324845	45
16	9.675390	9.944854	9.730535	10.269465	10.055146	10.324610	44
17	9.675625	9.944786	9.730838	10.269162	10.055214	10.324375	43
18	9.675859	9.944718	9.731141	10.268859	10.055282	10.324141	42
19	9.676094	9.944650	9.731444	10.268556	10.055350	10.323906	41
20	9.676328	9.944582	9.731746	10.268254	10.055418	10.323672	40
21	9.676562	9.944514	9.732048	10.267952	10.055486	10.323438	39
22	9.676796	9.944446	9.732351	10.267649	10.055554	10.323204	38
23	9.677030	9.944377	9.732653	10.267347	10.055623	10.322970	37
24	9.677264	9.944309	9.732955	10.267045	10.055691	10.322736	36
25	9.677498	9.944241	9.733257	10.266743	10.055759	10.322502	35
26	9.677731	9.944173	9.733558	10.266442	10.055827	10.322269	34
27	9.677964	9.944104	9.733860	10.266140	10.055896	10.322036	33
28	9.678197	9.944036	9.734162	10.265838	10.055964	10.321803	32
29	9.678430	9.943967	9.734463	10.265537	10.056033	10.321570	31
30	9.678663	9.943898	9.734764	10.265236	10.056102	10.321337	30
		Sine		Tangent		Secant	Minutes

61 Degrees.

28 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.678663	9.943898	9.734764	10.265236	10.056102	10.321337	30
31	9.678895	9.943830	9.735066	10.264934	10.056107	10.321105	29
32	9.679128	9.943761	9.735367	10.264633	10.056239	10.320872	28
33	9.679360	9.943693	9.735668	10.264332	10.056307	10.320640	27
34	9.679592	9.943624	9.735968	10.264032	10.056376	10.320408	26
35	9.679824	9.943555	9.736269	10.263731	10.056445	10.320176	25
36	9.680056	9.943486	9.736570	10.263430	10.056514	10.319944	24
37	9.680288	9.943417	9.736871	10.263129	10.056583	10.319712	23
38	9.680519	9.943348	9.737171	10.262829	10.056652	10.319481	22
39	9.680750	9.943279	9.737471	10.262529	10.056721	10.319250	21
40	9.680982	9.943210	9.737771	10.262229	10.056790	10.319018	20
41	9.681213	9.943141	9.738071	10.261929	10.056859	10.318787	19
42	9.681443	9.943072	9.738371	10.261629	10.056928	10.318557	18
43	9.681674	9.943003	9.738671	10.261329	10.056997	10.318326	17
44	9.681905	9.942934	9.738971	10.261029	10.057066	10.318095	16
45	9.682135	9.942864	9.739271	10.260729	10.057136	10.317865	15
46	9.682365	9.942795	9.739570	10.260430	10.057205	10.317635	14
47	9.682595	9.942725	9.739870	10.260130	10.057275	10.317405	13
48	9.682825	9.942656	9.740169	10.259831	10.057344	10.317175	12
49	9.683055	9.942587	9.740468	10.259532	10.057413	10.316945	11
50	9.683284	9.942517	9.740767	10.259233	10.057483	10.316716	10
51	9.683514	9.942448	9.741066	10.258934	10.057552	10.316486	9
52	9.683743	9.942378	9.741365	10.258635	10.057622	10.316257	8
53	9.683972	9.942308	9.741664	10.258336	10.057692	10.316028	7
54	9.684201	9.942239	9.741962	10.258038	10.057761	10.315799	6
55	9.684430	9.942169	9.742261	10.257739	10.057831	10.315570	5
56	9.684658	9.942099	9.742559	10.257441	10.057901	10.315342	4
57	9.684887	9.942029	9.74285[illegible]	10.257142	10.057971	10.315113	3
58	9.685115	9.941959	9.743156	10.256844	10.058041	10.314885	2
59	9.685343	9.941889	9.743454	10.256546	10.058111	10.314657	1
60	9.685571	9.941819	9.743752	10.256248	10.058181	10.314429	0
		Sine		Tangent		Secant	Minutes

61 Degrees.

29 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.685571	9.941819	9.743752	10.256248	10.058181	10.314429	60
1	9.685799	9.941749	9.744050	10.255950	10.058251	10.314201	59
2	9.686027	9.941679	9.744348	10.255652	10.058321	10.313973	58
3	9.686254	9.941609	9.744645	10.255355	10.058391	10.313746	57
4	9.686482	9.941539	9.744943	10.255057	10.058461	10.313518	56
5	9.686709	9.941468	9.745240	10.254760	10.058532	10.313291	55
6	9.686936	9.941398	9.745538	10.254462	10.058602	10.313064	54
7	9.687163	9.941328	9.745835	10.254165	10.058672	10.312837	53
8	9.687389	9.941258	9.746132	10.253868	10.058742	10.312611	52
9	9.687616	9.941187	9.746429	10.253571	10.058813	10.312384	51
10	9.687843	9.941117	9.746726	10.253274	10.058883	10.312157	50
11	9.688069	9.941046	9.747023	10.252977	10.058954	10.311931	49
12	9.688295	9.940975	9.747319	10.252681	10.059025	10.311705	48
13	9.688521	9.940905	9.747616	10.252384	10.059095	10.311479	47
14	9.688747	9.940834	9.747912	10.252088	10.059166	10.311253	46
15	9.688972	9.940763	9.748209	10.251791	10.059237	10.311028	45
16	9.689198	9.940693	9.748505	10.251495	10.059307	10.310802	44
17	9.689423	9.940622	9.748801	10.251199	10.059378	10.310577	43
18	9.689648	9.940551	9.749097	10.250903	10.059449	10.310352	42
19	9.689873	9.940480	9.749393	10.250607	10.059520	10.310127	41
20	9.690098	9.940409	9.749689	10.250311	10.059591	10.309902	40
21	9.690323	9.940338	9.749985	10.250015	10.059662	10.309677	39
22	9.690548	9.940267	9.750281	10.249719	10.059733	10.309452	38
23	9.690772	9.940196	9.750576	10.249424	10.059804	10.309228	37
24	9.690996	9.940125	9.750872	10.249128	10.059875	10.309004	36
25	9.691220	9.940053	9.751167	10.248833	10.059947	10.308780	35
26	9.691444	9.939982	9.751462	10.248538	10.060018	10.308556	34
27	9.691668	9.939911	9.751757	10.248243	10.060089	10.308332	33
28	9.691892	9.939840	9.752052	10.247948	10.060160	10.308108	32
29	9.692115	9.939768	9.752347	10.247653	10.060232	10.307885	31
30	9.692339	9.939697	9.752642	10.247358	10.060303	10.307661	30
		Sine		Tangent		Secant	Minutes

60 Degrees.

29 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.692339	9.939697	9.752642	10.247358	10.060303	10.307661	30
31	9.692562	9.939625	9.752937	10.247003	10.060375	10.307438	29
32	9.692785	9.939554	9.753231	10.246769	10.060446	10.307215	28
33	9.693009	9.939482	9.753526	10.246474	10.060518	10.306991	27
34	9.693231	9.939410	9.753820	10.246180	10.060590	10.306769	26
35	9.693453	9.939339	9.754115	10.245885	10.060661	10.306547	25
36	9.693676	9.939267	9.754409	10.245591	10.060733	10.306324	24
37	9.693898	9.939195	9.754703	10.245297	10.060805	10.306102	23
38	9.694120	9.939123	9.754997	10.245003	10.060877	10.305880	22
39	9.694342	9.939051	9.755291	10.244709	10.060949	10.305658	21
40	9.694564	9.938980	9.755585	10.244415	10.061020	10.305436	20
41	9.694786	9.938908	9.755878	10.244122	10.061092	10.305214	19
42	9.695007	9.938836	9.756172	10.243828	10.061164	10.304993	18
43	9.695229	9.938763	9.756465	10.243535	10.061237	10.304771	17
44	9.695450	9.938691	9.756759	10.243241	10.061309	10.304550	16
45	9.695671	9.938619	9.757052	10.242948	10.061381	10.304329	15
46	9.695892	9.938547	9.757345	10.242655	10.061453	10.304108	14
47	9.696113	9.938475	9.757638	10.242362	10.061525	10.303887	13
48	9.696334	9.938402	9.757931	10.242069	10.061598	10.303666	12
49	9.696554	9.938330	9.758224	10.241776	10.061670	10.303446	11
50	9.696774	9.938258	9.758517	10.241483	10.061742	10.303226	10
51	9.696995	9.938185	9.758810	10.241190	10.061815	10.303005	9
52	9.697215	9.938113	9.759102	10.240898	10.061887	10.302785	8
53	9.697435	9.938040	9.759395	10.240605	10.061960	10.302565	7
54	9.697654	9.937967	9.759687	10.240313	10.062033	10.302346	6
55	9.697874	9.937895	9.759979	10.240021	10.062105	10.302126	5
56	9.698094	9.937822	9.760272	10.239728	10.062178	10.301906	4
57	9.698313	9.937749	9.760564	10.239436	10.062251	10.301687	3
58	9.698532	9.937676	9.760856	10.239144	10.062324	10.301468	2
59	9.698751	9.937603	9.761148	10.238852	10.062397	10.301249	1
60	9.698970	9.937531	9.761439	10.238561	10.062469	10.301030	0
		Sine		Tangent		Secant	Minutes

60 Degrees.

30 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.698970	9.937531	9.761439	10.238561	10.062469	10.301030	60
1	9.699189	9.937458	9.761731	10.238269	10.062541	10.300811	59
2	9.699407	9.937385	9.762023	10.237977	10.062615	10.300593	58
3	9.699626	9.937312	9.762314	10.237686	10.062688	10.300374	57
4	9.699844	9.937238	9.762606	10.237394	10.062762	10.300156	56
5	9.700062	9.937165	9.762897	10.237103	10.062835	10.299938	55
6	9.700280	9.937092	9.763188	10.236812	10.062908	10.299720	54
7	9.700498	9.937019	9.763479	10.236521	10.062981	10.299502	53
8	9.700716	9.936946	9.763770	10.236230	10.063054	10.299284	52
9	9.700933	9.936872	9.764061	10.235939	10.063128	10.299067	51
10	9.701151	9.936799	9.764352	10.235648	10.063201	10.298849	50
11	9.701368	9.936725	9.764643	10.235357	10.063275	10.298632	49
12	9.701585	9.936652	9.764933	10.235067	10.063348	10.298415	48
13	9.701802	9.936578	9.765224	10.234776	10.063422	10.298198	47
14	9.702019	9.936505	9.765514	10.234486	10.063495	10.297981	46
15	9.702236	9.936431	9.765805	10.234195	10.063569	10.297764	45
16	9.702452	9.936357	9.766095	10.233905	10.063643	10.297548	44
17	9.702669	9.936284	9.766385	10.233615	10.063716	10.297331	43
18	9.702885	9.936210	9.766675	10.233325	10.063790	10.297115	42
19	9.703101	9.936136	9.766965	10.233035	10.063864	10.296899	41
20	9.703317	9.936062	9.767255	10.232745	10.063938	10.296683	40
21	9.703533	9.935988	9.767545	10.232455	10.064012	10.296467	39
22	9.703749	9.935914	9.767834	10.232166	10.064086	10.296251	38
23	9.703964	9.935840	9.768124	10.231876	10.064160	10.296036	37
24	9.704179	9.935766	9.768413	10.231587	10.064234	10.295821	36
25	9.704395	9.935692	9.768703	10.231297	10.064308	10.295605	35
26	9.704610	9.935618	9.768992	10.231008	10.064382	10.295390	34
27	9.704825	9.935543	9.769281	10.230719	10.064457	10.295175	33
28	9.705040	9.935469	9.769570	10.230430	10.064531	10.294960	32
29	9.705254	9.935395	9.769860	10.230140	10.064605	10.294746	31
30	9.705469	9.935320	9.770148	10.229852	10.064680	10.294531	30
		Sine		Tangent		Secant	Minntes

59 Degrees.

30 Degrees:

Minutes	Sine		Tangent		Secant		
30	9.705469	9.935320	9.770148	10.229852	10.064680	10.294531	30
31	9.705683	9.935246	9.770437	10.229563	10.064754	10.294317	29
32	9.705897	9.935171	9.770726	10.229274	10.064829	10.294103	28
33	9.706112	9.935097	9.771015	10.228985	10.064903	10.293888	27
34	9.706326	9.935022	9.771303	10.228697	10.064978	10.293674	26
35	9.706539	9.934948	9.771592	10.228408	10.065052	10.293461	25
36	9.706753	9.934873	9.771880	10.228120	10.065127	10.293247	24
37	9.706967	9.934798	9.772168	10.227832	10.065202	10.293033	23
38	9.707180	9.934723	9.772457	10.227543	10.065277	10.292820	22
39	9.707393	9.934649	9.772745	10.227255	10.065351	10.292607	21
40	9.707606	9.934574	9.773033	10.226967	10.065426	10.292394	20
41	9.707819	9.934499	9.773321	10.226679	10.065501	10.292181	19
42	9.708032	9.934424	9.773608	10.226392	10.065576	10.291968	18
43	9.708245	9.934349	9.773896	10.226104	10.065651	10.291755	17
44	9.708457	9.934274	9.774184	10.225816	10.065726	10.291543	16
45	9.708670	9.934199	9.774471	10.225529	10.065801	10.291330	15
46	9.708882	9.934123	9.774759	10.225241	10.065877	10.291118	14
47	9.709094	9.934048	9.775046	10.224954	10.065952	10.290906	13
48	9.709306	9.933973	9.775333	10.224667	10.066027	10.290694	12
49	9.709518	9.933898	9.775621	10.224379	10.066102	10.290482	11
50	9.709730	9.933822	9.775908	10.224092	10.066178	10.290270	10
51	9.709941	9.933747	9.776195	10.223805	10.066253	10.290059	9
52	9.710153	9.933671	9.776482	10.223518	10.066329	10.289847	8
53	9.710364	9.933596	9.776769	10.223231	10.066404	10.289636	7
54	9.710575	9.933520	9.777055	10.222945	10.066480	10.289425	6
55	9.710786	9.933444	9.777342	10.222658	10.066556	10.289214	5
56	9.710997	9.933369	9.777628	10.222372	10.066631	10.289003	4
57	9.711208	9.933293	9.777915	10.222085	10.066707	10.288792	3
58	9.711419	9.933217	9.778201	10.221799	10.066783	10.288581	2
59	9.711629	9.933141	9.778487	10.221513	10.066859	10.288371	1
60	9.711839	9.933066	9.778774	10.221226	10.066934	10.288161	0
		Sine		Tangent		Secant	Minutes

59 Degrees.

31 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.711839	9.933066	9.778774	10.221226	10.066934	10.288161	60
1	9.712049	9.932990	9.779060	10.220940	10.067010	10.287951	59
2	9.712259	9.932914	9.779346	10.220654	10.067086	10.287741	58
3	9.712469	9.932838	9.779632	10.220368	10.067162	10.287531	57
4	9.712679	9.932762	9.779918	10.220082	10.067238	10.287321	56
5	9.712889	9.932685	9.780203	10.219797	10.067315	10.287111	55
6	9.713098	9.932609	9.780489	10.219511	10.067391	10.286902	54
7	9.713308	9.932533	9.780775	10.219225	10.067467	10.286692	53
8	9.713517	9.932457	9.781060	10.218940	10.067543	10.286483	52
9	9.713726	9.932380	9.781346	10.218654	10.067620	10.286274	51
10	9.713935	9.932304	9.781631	10.218369	10.067696	10.286065	50
11	9.714144	9.932228	9.781916	10.218084	10.067772	10.285856	49
12	9.714352	9.932151	9.782201	10.217799	10.067849	10.285648	48
13	9.714561	9.932075	9.782486	10.217514	10.067925	10.285439	47
14	9.714769	9.931998	9.782771	10.217229	10.068002	10.285231	46
15	9.714978	9.931921	9.783056	10.216944	10.068079	10.285022	45
16	9.715186	9.931845	9.783341	10.216659	10.068155	10.284814	44
17	9.715394	9.931768	9.783626	10.216374	10.068232	10.284606	43
18	9.715601	9.931691	9.783910	10.216090	10.068309	10.284399	42
19	9.715809	9.931614	9.784195	10.215805	10.068386	10.284191	41
20	9.716017	9.931537	9.784479	10.215521	10.068463	10.283983	40
21	9.716224	9.931460	9.784764	10.215236	10.068540	10.283776	39
22	9.716432	9.931383	9.785048	10.214952	10.068617	10.283568	38
23	9.716639	9.931306	9.785332	10.214668	10.068694	10.283361	37
24	9.716846	9.931229	9.785616	10.214384	10.068771	10.283154	36
25	9.717053	9.931152	9.785900	10.214100	10.068848	10.282947	35
26	9.717259	9.931075	9.786184	10.213816	10.068925	10.282741	34
27	9.717466	9.930998	9.786468	10.213532	10.069002	10.282534	33
28	9.717672	9.930920	9.786752	10.213248	10.069080	10.282328	32
29	9.717879	9.930843	9.787036	10.212964	10.069157	10.282121	31
30	9.718085	9.930766	9.787319	10.212681	10.069234	10.281915	30
		Sine		Tangent		Secant	Minutes

58 Degrees.

31 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.718085	9.930766	9.787319	10.212681	10.069234	10.281915	30
31	9.718291	9.930688	9.787603	10.212397	10.069312	10.281709	29
32	9.718497	9.930611	9.787886	10.212114	10.069389	10.281503	28
33	9.718703	9.930533	9.788170	10.211830	10.069467	10.281297	27
34	9.718909	9.930456	9.788453	10.211547	10.069544	10.281091	26
35	9.719114	9.930378	9.788736	10.211264	10.069622	10.280886	25
36	9.719320	9.930300	9.789019	10.210981	10.069700	10.280680	24
37	9.719525	9.930223	9.789302	10.210698	10.069777	10.280475	23
38	9.719730	9.930145	9.789585	10.210415	10.069855	10.280270	22
39	9.719935	9.930067	9.789868	10.210132	10.069933	10.280065	21
40	9.720140	9.929989	9.790151	10.209849	10.070011	10.279860	20
41	9.720345	9.929911	9.790433	10.209567	10.070089	10.279655	19
42	9.720549	9.929833	9.790716	10.209284	10.070167	10.279451	18
43	9.720754	9.929755	9.790999	10.209001	10.070245	10.279246	17
44	9.720958	9.929677	9.791281	10.208719	10.070323	10.279042	16
45	9.721162	9.929599	9.791563	10.208437	10.070401	10.278838	15
46	9.721366	9.929521	9.791846	10.208154	10.070479	10.278634	14
47	9.721570	9.929442	9.792128	10.207872	10.070558	10.278430	13
48	9.721774	9.929364	9.792410	10.207590	10.070636	10.278226	12
49	9.721978	9.929286	9.792692	10.207308	10.070714	10.278022	11
50	9.722181	9.929207	9.792974	10.207026	10.070793	10.277819	10
51	9.722385	9.929129	9.793256	10.206744	10.070871	10.277615	9
52	9.722588	9.929050	9.793538	10.206462	10.070950	10.277412	8
53	9.722791	9.928972	9.793819	10.206181	10.071028	10.277209	7
54	9.722994	9.928893	9.794101	10.205899	10.071107	10.277006	6
55	9.723197	9.928814	9.794383	10.205617	10.071186	10.276803	5
56	9.723400	9.928736	9.794664	10.205336	10.071264	10.276600	4
57	9.723603	9.928657	9.794945	10.205055	10.071343	10.276397	3
58	9.723805	9.928578	9.795227	10.204773	10.071422	10.276195	2
59	9.724007	9.928499	9.795508	10.204492	10.071501	10.275993	1
60	9.724210	9.928420	9.795789	10.204211	10.071580	10.275790	0
		Sine		Tangent		Secant	Minutes

58 Degrees.

32 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.724210	9.928420	9.795789	10.204211	10.071580	10.275790	60
1	9.724412	9.928341	9.796070	10.203930	10.071659	10.275588	59
2	9.724614	9.928262	9.796351	10.203649	10.071738	10.275386	58
3	9.724816	9.928183	9.796632	10.203368	10.071817	10.275184	57
4	9.725017	9.928104	9.796913	10.203087	10.071896	10.274983	56
5	9.725219	9.928025	9.797194	10.202806	10.071975	10.274781	55
6	9.725420	9.927946	9.797474	10.202526	10.072054	10.274580	54
7	9.725622	9.927867	9.797755	10.202245	10.072133	10.274378	53
8	9.725823	9.927787	9.798036	10.201964	10.072213	10.274177	52
9	9.726024	9.927708	9.798316	10.201684	10.072294	10.273976	51
10	9.726225	9.927628	9.798596	10.201404	10.072372	10.273775	50
11	9.726426	9.927549	9.798877	10.201123	10.072451	10.273574	49
12	9.726626	9.927469	9.799157	10.200843	10.072531	10.273374	48
13	9.726827	9.927390	9.799437	10.200563	10.072610	10.273173	47
14	9.727027	9.927310	9.799717	10.200283	10.072690	10.272973	46
15	9.727228	9.927231	9.799997	10.200003	10.072769	10.272772	45
16	9.727428	9.927151	9.800277	10.199723	10.072849	10.272572	44
17	9.727628	9.927071	9.800557	10.199443	10.072929	10.272372	43
18	9.727828	9.926991	9.800836	10.199164	10.073009	10.272172	42
19	9.728027	9.926911	9.801116	10.198884	10.073089	10.271973	41
20	9.728227	9.926831	9.801396	10.198604	10.073169	10.271773	40
21	9.728427	9.926751	9.801675	10.198325	10.073249	10.271573	39
22	9.728626	9.926671	9.801955	10.198045	10.073329	10.271374	38
23	9.728825	9.926591	9.802234	10.197766	10.073409	10.271175	37
24	9.729024	9.926511	9.802513	10.197487	10.073489	10.270976	36
25	9.729223	9.926431	9.802792	10.197208	10.073569	10.270777	35
26	9.729422	9.926351	9.803072	10.196928	10.073649	10.270578	34
27	9.729621	9.926270	9.803351	10.196649	10.073730	10.270379	33
28	9.729816	9.926190	9.803630	10.196370	10.073810	10.270184	32
29	9.730018	9.926110	9.803908	10.196092	10.073890	10.269982	31
30	9.730216	9.926029	9.804187	10.195813	10.073971	10.269784	30
		Sine		Tangent		Secant	Minutes

57 Degrees.

32 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.730216	9.926029	9.804187	10.195813	10.073971	10.269784	30
31	9.730415	9.925949	9.804466	10.195534	10.074051	10.269585	29
32	9.730613	9.925868	9.804745	10.195255	10.074132	10.269387	28
33	9.730811	9.925787	9.805023	10.194977	10.074213	10.269189	27
34	9.731009	9.925707	9.805302	10.194698	10.074293	10.268991	26
35	9.731206	9.925626	9.805580	10.194420	10.074374	10.268794	25
36	9.731404	9.925545	9.805859	10.194141	10.074455	10.268596	24
37	9.731601	9.925465	9.806137	10.193863	10.074535	10.268399	23
38	9.731799	9.925384	9.806415	10.193585	10.074616	10.268201	22
39	9.731996	9.925303	9.806693	10.193307	10.074697	10.268004	21
40	9.732193	9.925222	9.806971	10.193029	10.074778	10.267807	20
41	9.732390	9.925141	9.807249	10.192751	10.074859	10.267610	19
42	9.732587	9.925060	9.807527	10.192473	10.074940	10.267413	18
43	9.732784	9.924979	9.807805	10.192195	10.075021	10.267216	17
44	9.732980	9.924897	9.808083	10.191917	10.075103	10.267020	16
45	9.733177	9.924816	9.808361	10.191639	10.075184	10.266823	15
46	9.733373	9.924735	9.808638	10.191362	10.075265	10.266627	14
47	9.733569	9.924653	9.808916	10.191084	10.075347	10.266431	13
48	9.733765	9.924572	9.809193	10.190807	10.075428	10.266235	12
49	9.733961	9.924491	9.809471	10.190529	10.075509	10.266039	11
50	9.734157	9.924409	9.809748	10.190252	10.075591	10.265843	10
51	9.734353	9.924328	9.810025	10.189975	10.075672	10.265647	9
52	9.734548	9.924246	9.810302	10.189698	10.075754	10.265452	8
53	9.734744	9.924164	9.810580	10.189420	10.075836	10.265256	7
54	9.734939	9.924083	9.810857	10.189143	10.075917	10.265061	6
55	9.735134	9.924001	9.811134	10.188866	10.075999	10.264866	5
56	9.735330	9.923919	9.811410	10.188590	10.076081	10.264670	4
57	9.735525	9.923837	9.811687	10.188313	10.076163	10.264475	3
58	9.735719	9.923755	9.811964	10.188036	10.076245	10.264281	2
59	9.735914	9.923673	9.812241	10.187759	10.076327	10.264086	1
60	9.736109	9.923591	9.812517	10.187483	10.076409	10.263891	0
		Sine		Tangent		Secant	Minutes

57 Degrees.

33 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.736109	9.923591	9.812517	10.187483	10.076409	10.263891	60
1	9.736303	9.923509	9.812794	10.187206	10.076491	10.263697	59
2	9.736498	9.923427	9.813070	10.186930	10.076573	10.263502	58
3	9.736692	9.923345	9.813347	10.186653	10.076655	10.263308	57
4	9.736886	9.923263	9.813623	10.186377	10.076737	10.263114	56
5	9.737080	9.923180	9.813899	10.186101	10.076820	10.262920	55
6	9.737274	9.923098	9.814175	10.185825	10.076902	10.262726	54
7	9.737467	9.923016	9.814452	10.185548	10.076984	10.262533	53
8	9.737661	9.922933	9.814728	10.185272	10.077067	10.262339	52
9	9.737855	9.922851	9.815004	10.184996	10.077149	10.262145	51
10	9.738048	9.922768	9.815279	10.184721	10.077232	10.261952	50
11	9.738241	9.922686	9.815555	10.184445	10.077314	10.261759	49
12	9.738434	9.922603	9.815831	10.184169	10.077397	10.261566	48
13	9.738627	9.922520	9.816107	10.183893	10.077480	10.261373	47
14	9.738820	9.922438	9.816382	10.183618	10.077562	10.261180	46
15	9.739013	9.922355	9.816658	10.183342	10.077645	10.260987	45
16	9.739205	9.922272	9.816933	10.183067	10.077728	10.260795	44
17	9.739398	9.922189	9.817209	10.182791	10.077811	10.260602	43
18	9.739590	9.922106	9.817484	10.182516	10.077894	10.260410	42
19	9.739783	9.922023	9.817759	10.182241	10.077977	10.260217	41
20	9.739975	9.921940	9.818035	10.181965	10.078060	10.260025	40
21	9.740167	9.921857	9.818310	10.181690	10.078143	10.259833	39
22	9.740359	9.921774	9.818585	10.181415	10.078226	10.259641	38
23	9.740550	9.921691	9.818860	10.181140	10.078309	10.259450	37
24	9.740742	9.921607	9.819135	10.180865	10.078393	10.259258	36
25	9.740934	9.921524	9.819410	10.180590	10.078476	10.259066	35
26	9.741125	9.921441	9.819684	10.180316	10.078559	10.258875	34
27	9.741316	9.921357	9.819959	10.180041	10.078643	10.258684	33
28	9.741507	9.921274	9.820234	10.179766	10.078726	10.258493	32
29	9.741699	9.921190	9.820508	10.179492	10.078810	10.258301	31
30	9.741889	9.921107	9.820783	10.179217	10.078893	10.258111	30
		Sine		Tangent		Secant	Minntes

56 Degrees.

33 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.741889	9.921107	9.820783	10.179217	10.078893	10.258111	30
31	9.742080	9.921023	9.821057	10.178943	10.078977	10.257920	29
32	9.742271	9.920939	9.821332	10.178668	10.079061	10.257729	28
33	9.742462	9.920855	9.821606	10.178394	10.079145	10.257538	27
34	9.742652	9.920772	9.821880	10.178120	10.079228	10.257348	26
35	9.742842	9.920688	9.822154	10.177846	10.079312	10.257158	25
36	9.743033	9.920604	9.822429	10.177571	10.079396	10.256967	24
37	9.743223	9.920520	9.822703	10.177297	10.079480	10.256777	23
38	9.743413	9.920436	9.822977	10.177023	10.079564	10.256587	22
39	9.743602	9.920352	9.823250	10.176750	10.079648	10.256398	21
40	9.743792	9.920268	9.823524	10.176476	10.079732	10.256208	20
41	9.743982	9.920184	9.823798	10.176202	10.079816	10.256018	19
42	9.744171	9.920099	9.824072	10.175928	10.079901	10.255829	18
43	9.744361	9.920015	9.824345	10.175655	10.079985	10.255639	17
44	9.744550	9.919931	9.824619	10.175381	10.080069	10.255450	16
45	9.744739	9.919846	9.824893	10.175107	10.080154	10.255261	15
46	9.744928	9.919762	9.825166	10.174834	10.080238	10.255072	14
47	9.745117	9.919677	9.825439	10.174561	10.080323	10.254883	13
48	9.745306	9.919593	9.825713	10.174287	10.080407	10.254694	12
49	9.745494	9.919508	9.825986	10.174014	10.080492	10.254506	11
50	9.745683	9.919424	9.826259	10.173741	10.080576	10.254317	10
51	9.745871	9.919339	9.826532	10.173468	10.080661	10.254129	9
52	9.746059	9.919254	9.826805	10.173195	10.080746	10.253941	8
53	9.746248	9.919169	9.827078	10.172922	10.080831	10.253752	7
54	9.746436	9.919084	9.827351	10.172649	10.080916	10.253564	6
55	9.746624	9.919000	9.827624	10.172376	10.081000	10.253376	5
56	9.746811	9.918915	9.827897	10.172103	10.081085	10.253189	4
57	9.746999	9.918830	9.828170	10.171830	10.081170	10.253001	3
58	9.747187	9.918744	9.828442	10.171558	10.081256	10.252813	2
59	9.747374	9.918659	9.828715	10.171285	10.081341	10.252626	1
60	9.747562	9.918574	9.828987	10.171013	10.081426	10.252438	0
		Sine		Tangent		Secant	Minutes

56 Degrees.

34 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.747562	9.918574	9.828987	10.171013	10.081426	10.252438	60
1	9.747749	9.918489	9.829260	10.170740	10.081511	10.252251	59
2	9.747936	9.918404	9.829532	10.170468	10.081596	10.252064	58
3	9.748123	9.918318	9.829805	10.170195	10.081682	10.251877	57
4	9.748310	9.918233	9.830077	10.169923	10.081767	10.251690	56
5	9.748497	9.918147	9.830349	10.169651	10.081853	10.251503	55
6	9.748683	9.918062	9.830621	10.169379	10.081938	10.251317	54
7	9.748870	9.917976	9.830893	10.169107	10.082024	10.251130	53
8	9.749056	9.917891	9.831165	10.168835	10.082109	10.250944	52
9	9.749242	9.917805	9.831437	10.168563	10.082195	10.250758	51
10	9.749429	9.917719	9.831709	10.168291	10.082281	16.250571	50
11	9.749615	9.917634	9.831981	10.168019	10.082366	10.250385	49
12	9.749801	9.917548	9.832253	10.167747	10.082452	10.250199	48
13	9.749987	9.917462	9.832525	10.167475	10.082538	10.250013	47
14	9.750172	9.917376	9.832796	10.167204	10.082624	10.249828	46
15	9.750358	9.917290	9.833068	10.166932	10.082710	10.249642	45
16	9.750543	9.917204	9.833339	10.166661	10.082796	10.249457	44
17	9.750729	9.917118	9.833611	10.166389	10.082882	10.249271	43
18	9.750914	9.917032	9.833882	10.166118	10.082968	10.249086	42
19	9.751099	9.916945	9.834154	10.165846	10.083055	10.248901	41
20	9.751284	9.916859	9.834425	10.165575	10.083141	10.248716	40
21	9.751469	9.916773	9.834696	10.165304	10.083227	10.248531	39
22	9.751654	9.916687	9.834967	10.165033	10.083313	10.248346	38
23	9.751838	9.916600	9.835238	10.164762	10.083400	10.248162	37
24	9.752023	9.916514	9.835509	10.164491	10.083486	10.247977	36
25	9.752207	9.916427	9.835780	10.164220	10.083573	10.247793	35
26	9.752392	9.916341	9.836051	10.163949	10.083659	10.247608	34
27	9.752576	9.916254	9.836322	10.163678	10.083746	10.247424	33
28	9.752760	9.916167	9.836593	10.163407	10.083833	10.247240	32
29	9.752944	9.916080	9.836864	10.163136	10.083920	10.247056	31
30	9.753128	9.916994	9.837134	10.162866	10.084006	10.246872	30
		Sine		Tangent		Secant	Minutes

55 Degrees.

34 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.753128	9.915994	9.837134	10.162866	10.084006	10.246872	30
31	9.753312	9.915907	9.837405	10.162595	10.084093	10.246688	29
32	9.753495	9.915820	9.837675	10.162325	10.084180	10.246505	28
33	9.753679	9.915733	9.837946	10.162054	10.084267	10.246321	27
34	9.753862	9.915646	9.838216	10.161784	10.084354	10.246138	26
35	9.754046	9.915559	9.838487	10.161513	10.084441	10.245954	25
36	9.754229	9.915472	9.838757	10.161243	10.084528	10.245771	24
37	9.754412	9.915385	9.839027	10.160973	10.084615	10.245588	23
38	9.754595	9.915297	9.839297	10.160703	10.084703	10.245405	22
39	9.754778	9.915210	9.839568	10.160432	10.084790	10.245222	21
40	9.754960	9.915123	9.839838	10.160162	10.084877	10.245040	20
41	9.755143	9.915035	9.840108	10.159892	10.084965	10.244857	19
42	9.755326	9.914948	9.840378	10.159622	10.085052	10.244674	18
43	9.755508	9.914860	9.840647	10.159353	10.085140	10.244492	17
44	9.755690	9.914773	9.840917	10.159083	10.085227	10.244310	16
45	9.755872	9.914685	9.841187	10.158813	10.085315	10.244128	15
46	9.756054	9.914598	9.841457	10.158543	10.085402	10.243946	14
47	9.756236	9.914510	9.841726	10.158274	10.085490	10.243764	13
48	9.756418	9.914422	9.841996	10.158004	10.085578	10.243582	12
49	9.756600	9.914334	9.842266	10.157734	10.085666	10.243400	11
50	9.756781	9.914246	9.842535	10.157465	10.085754	10.243219	10
51	9.756963	9.914158	9.842805	10.157195	10.085842	10.243037	9
52	9.757144	9.914070	9.843074	10.156926	10.085930	10.242856	8
53	9.757326	9.913982	9.843343	10.156657	10.086018	10.242674	7
54	9.757507	9.913894	9.843612	10.156388	10.086106	10.242495	6
55	9.757688	9.913806	9.843882	10.156118	10.086194	10.242312	5
56	9.757869	9.913718	9.844151	10.155849	10.086282	10.242131	4
57	9.758049	9.913630	9.844420	10.155580	10.086370	10.241951	3
58	9.758230	9.913541	9.844689	10.155311	10.086459	10.241770	2
59	9.758411	9.913453	9.844958	10.155042	10.086547	10.241589	1
60	9.758591	9.913364	9.845227	10.154773	10.086636	10.241409	0
		Sine		Tangent		Secant	Minutes

55 Degrees.

35 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.758591	9.913364	9.845227	10.154773	10.086636	10.241409	60
1	9.758772	9.913276	9.845496	10.154504	10.086724	10.241228	59
2	9.758952	9.913187	9.845764	10.154236	10.086813	10.241048	58
3	9.759132	9.913099	9.846033	10.153967	10.086901	10.240868	57
4	9.759312	9.913010	9.846302	10.153698	10.086990	10.240688	56
5	9.759492	9.912921	9.846570	10.153430	10.087079	10.240508	55
6	9.759672	9.912833	9.846839	10.153161	10.087167	10.240328	54
7	9.759851	9.912744	9.847107	10.152893	10.087256	10.240149	53
8	9.760031	9.912655	9.847376	10.152624	10.087345	10.239969	52
9	9.760211	9.912566	9.847644	10.152356	10.087434	10.239789	51
10	9.760390	9.912477	9.847913	10.152087	10.087523	10.239610	50
11	9.760569	9.912388	9.848181	10.151819	10.087612	10.239431	49
12	9.760748	9.912299	9.848449	10.151551	10.087701	10.239252	48
13	9.760927	9.912210	9.848717	10.151283	10.087790	10.239073	47
14	9.761106	9.912121	9.848985	10.151015	10.087879	10.238894	46
15	9.761285	9.912031	9.849254	10.150746	10.087969	10.238715	45
16	9.761464	9.911942	9.849522	10.150478	10.088058	10.238536	44
17	9.761642	9.911853	9.849790	10.150210	10.088147	10.238358	43
18	9.761821	9.911763	9.850057	10.149943	10.088237	10.238179	42
19	9.761999	9.911674	9.850325	10.149675	10.088326	10.238001	41
20	9.762177	9.911584	9.850593	10.149407	10.088416	10.237823	40
21	9.762356	9.911495	9.850861	10.149139	10.088505	10.237644	39
22	9.762534	9.911405	9.851128	10.148872	10.088595	10.237466	38
23	9.762712	9.911315	9.851396	10.148604	10.088685	10.237288	37
24	9.762889	9.911226	9.851664	10.148336	10.088774	10.237111	36
25	9.763067	9.911136	9.851931	10.148069	10.088864	10.236933	35
26	9.763245	9.911046	9.852199	10.147801	10.088954	10.236755	34
27	9.763422	9.910956	9.852466	10.147534	10.089044	10.236578	33
28	9.763600	9.910866	9.852733	10.147267	10.089134	10.236400	32
29	9.763777	9.910776	9.853001	10.146999	10.089224	10.236223	31
30	9.763954	9.910686	9.853268	10.146732	10.089314	10.236046	30
		Sine		Tangent		Secant	Minutes

54 Degrees.

35 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.763954	9.910686	9.853268	10.146732	10.089314	10.236046	30
31	9.764131	9.910596	9.853535	10.146465	10.089404	10.235869	29
32	9.764308	9.910506	9.853802	10.146198	10.089494	10.235692	28
33	9.764485	9.910415	9.854069	10.145931	10.089585	10.235515	27
34	9.764662	9.910325	9.854336	10.145664	10.089675	10.235338	26
35	9.764838	9.910235	9.854603	10.145397	10.089765	10.235162	25
36	9.765015	9.910144	9.854870	10.145130	10.089856	10.234985	24
37	9.765191	9.910054	9.855137	10.144863	10.089946	10.234809	23
38	9.765367	9.909963	9.855404	10.144596	10.090037	10.234633	22
39	9.765544	9.909873	9.855671	10.144329	10.090127	10.234456	21
40	9.765720	9.909782	9.855938	10.144062	10.090218	10.234280	20
41	9.765896	9.909691	9.856204	10.143796	10.090309	10.234104	19
42	9.766071	9.909601	9.856471	10.143529	10.090399	10.233929	18
43	9.766247	9.909510	9.856737	10.143263	10.090490	10.233753	17
44	9.766423	9.909419	9.857004	10.142996	10.090581	10.233577	16
45	9.766598	9.909328	9.857270	10.142730	10.090672	10.233402	15
46	9.766774	9.909237	9.857537	10.142463	10.090763	10.233226	14
47	9.766949	9.909146	9.857803	10.142197	10.090854	10.233051	13
48	9.767124	9.909055	9.858069	10.141931	10.090945	10.232876	12
49	9.767300	9.908964	9.858336	10.141664	10.091036	10.232700	11
50	9.767475	9.908873	9.858602	10.141398	10.091127	10.232525	10
51	9.767649	9.908781	9.858868	10.141132	10.091219	10.232351	9
52	9.767824	9.908690	9.859134	10.140866	10.091310	10.232176	8
53	9.767999	9.908599	9.859400	10.140600	10.091401	10.232001	7
54	9.768173	9.908507	9.859666	10.140334	10.091493	10.231827	6
55	9.768348	9.908416	9.859932	10.140068	10.091584	10.231652	5
56	9.768522	9.908324	9.860198	10.139802	10.091676	10.231478	4
57	9.768697	9.908233	9.860464	10.139536	10.091767	10.231303	3
58	9.768871	9.908141	9.860730	10.139270	10.091859	10.231129	2
59	9.769045	9.908049	9.860995	10.139005	10.091951	10.230955	1
60	9.769219	9.907958	9.861261	10.138739	10.092042	10.230781	0
		Sine		Tangent		Secant	Minutes

54 Degrees.

36 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.769219	9.907958	9.861261	10.138739	10.092042	10.230781	60
1	9.769392	9.907866	9.861527	10.138473	10.092134	10.230608	59
2	9.769566	9.907774	9.861792	10.138208	10.092226	10.230434	58
3	9.769740	9.907682	9.862058	10.137942	10.092318	10.230260	57
4	9.769912	9.907590	9.862323	10.137677	10.092410	10.230088	56
5	9.770087	9.907498	9.862589	10.137411	10.092502	10.229913	55
6	9.770260	9.907406	9.862854	10.137146	10.092594	10.229740	54
7	9.770433	9.907314	9.863119	10.136881	10.092686	10.229567	53
8	9.770606	9.907222	9.863385	10.136615	10.092778	10.229394	52
9	9.770779	9.907129	9.863650	10.136350	10.092871	10.229221	51
10	9.770952	9.907037	9.863915	10.136085	10.092963	10.229048	50
11	9.771125	9.906945	9.864180	10.135820	10.093055	10.228875	49
12	9.771298	9.906852	9.864445	10.135555	10.093148	10.228702	48
13	9.771470	9.906760	9.864711	10.135289	10.093240	10.228530	47
14	9.771643	9 906667	9.864975	10.135025	10.093333	10.228357	46
15	9.771815	9.906574	9.865240	10.134760	10.093426	10.228185	45
16	9.771987	9.906482	9.865505	10.134495	10.093518	10.228013	44
17	9.772159	9.906389	9.865770	10.134230	10.093611	10.227841	43
18	9.772331	9.906296	9.866035	10.133965	10.093704	10.227669	42
19	9.772503	9.906204	9.866300	10.133700	10.093796	10.227497	41
20	9.772675	9.906111	9.866564	10.133436	10.093889	10.227325	40
21	9.772847	9.906018	9.866829	10.133171	10.093982	10.227153	39
22	9.773018	9.905925	9.867094	10.132906	10.094075	10.226982	38
23	9.773190	9.905832	9.867358	10.132642	10.094168	10.226810	37
24	9.773361	9.905739	9.867623	10.132377	10.094261	10.226639	36
25	9.773533	9.905645	9.867887	10.132113	10.094355	10.226467	35
26	9.773704	9.905552	9.868152	10.131848	10.094448	10.226296	34
27	9.773875	9.905459	9.868416	10.131584	10.094541	10.226125	33
28	9.774046	9.905366	9.868680	10.131320	10.094634	10.225954	32
29	9.774217	9.905272	9.868945	10.131055	10.094726	10.225783	31
30	9.774388	9.905179	9.869209	10.130791	10.094821	10.225612	30
		Sine		Tangent		Secant	Minutes

53 Degrees.

36 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.774388	9.905179	9.869209	10.130791	10.094821	10.225612	30
31	9.774558	9.905085	9.869473	10.130527	10.094915	10.225442	29
32	9.774729	9.904992	9.869737	10.130263	10.095008	10.225271	28
33	9.774899	9.904898	9.870001	10.129999	10.095102	10.225101	27
34	9.775070	9.904804	9.870265	10.129735	10.095196	10.224930	26
35	9.775240	9.904711	9.870529	10.129471	10.095289	10.224760	25
36	9.775410	9.904617	9.870793	10.129207	10.095383	10.224590	24
37	9.775580	9.904523	9.871057	10.128943	10.095477	10.224420	23
38	9.775750	9.904429	9.871321	10.128679	10.095571	10.224250	22
39	9.775920	9.904335	9.871585	10.128415	10.095665	10.224080	21
40	9.776090	9.904241	9.871849	10.128151	10.095759	10.223910	20
41	9.776259	9.904147	9.872112	10.127888	10.095853	10.223741	19
42	9.776429	9.904053	9.872376	10.127624	10.095947	10.223571	18
43	9.776598	9.903959	9.872640	10.127360	10.096041	10.223402	17
44	9.776768	9.903864	9.872903	10.127097	10.096136	10.223232	16
45	9.776937	9.903770	9.873167	10.126833	10.096230	10.223063	15
46	9.777106	9.903676	9.873430	10.126570	10.096324	10.222894	14
47	9.777275	9.903581	9.873694	10.126306	10.096419	10.222725	13
48	9.777444	9.903487	9.873957	10.126043	10.096513	10.222556	12
49	9.777613	9.903392	9.874220	10.125780	10.096608	10.222387	11
50	9.777781	9.903298	9.874484	10.125516	10.096702	10.222219	10
51	9.777950	9.903203	9.874747	10.125253	10.096797	10.222050	9
52	9.778119	9.903108	9.875010	10.124990	10.096892	10.221881	8
53	9.778287	9.903014	9.875273	10.124727	10.096986	10.221713	7
54	9.778455	9.902919	9.875536	10.124464	10.097081	10.221545	6
55	9.778623	9.902824	9.875800	10.124200	10.097176	10.221377	5
56	9.778792	9.902729	9.876063	10.123937	10.097271	10.221208	4
57	9.778960	9.902634	9.876326	10.123674	10.097366	10.221040	3
58	9.779128	9.902539	9.876589	10.123411	10.097461	10.220872	2
59	9.779295	9.902444	9.876851	10.123149	10.097556	10.220705	1
60	9.779463	9.902349	9.877114	10.122886	10.097651	10.220537	0
		Sine		Tangent		Secant	Minutes

53 Degrees.

37 Degrees.

Minutes	Sine		Tangent		Secant		
0	9·779463	9·902349	9·877114	10.122886	10.097651	10.220537	60
1	9·779631	9·902253	9·877377	10.122623	10.097747	10.220369	59
2	9·779798	9·902158	9·877640	10.122360	10.097842	10.220202	58
3	9·779965	9·902063	9·877903	10.122097	10.097937	10.220035	57
4	9·780133	9·901967	9·878165	10.121835	10.098033	10.219867	56
5	9·780300	9·901872	9·878428	10.121572	10.098128	10.219700	55
6	9·780467	9·901776	9·878691	10.121309	10.098224	10.219533	54
7	9·280634	9·901681	9·878953	10.121047	10.098319	10.219366	53
8	9·780801	9·901585	9·879216	10.120784	10.098415	10.219199	52
9	9·780968	9·901489	9·879478	10.120522	10.098511	10.219032	51
10	9·781134	9·901394	9·879741	10.120259	10.098606	10.218866	50
11	9·781301	9·901298	9·880003	10.119997	10.098702	10.218699	49
12	9·781467	9·901202	9·880265	10.119735	10.098798	10.218533	48
13	9·781634	9·901106	9·880528	10.119472	10.098894	10.218366	47
14	9·781800	9·901010	9·880790	10.119210	10.098990	10.218200	46
15	9·781966	9·900914	9·881052	10.118948	10.099086	10.218034	45
16	9·782132	9·900818	9·881314	10.118686	10.099182	10.217868	44
17	9·782298	9·900722	9·881576	10.118424	10.099278	10.217702	43
18	9·782464	9·900626	9·881839	10.118161	10.099374	10.217536	42
19	9·782630	9·900529	9·882101	10.117899	10.099471	10.217370	41
20	9·782796	9·900433	9·882363	10.117637	10.099567	10.217204	40
21	9·782961	9·900337	9·882625	10.117375	10.099663	10.217039	39
22	9·783127	9·900240	9·882887	10.117113	10.099760	10.216873	38
23	9·783292	9·900144	9·883148	10.116852	10.099856	10.216708	37
24	9·783457	9·900047	9·883410	10.116590	10.099953	10.216543	36
25	9·783623	9·899951	9·883672	10.116328	10.100049	10.216377	35
26	9·783788	9·899854	9·883934	10.116066	10.100146	10.216212	34
27	9·783953	9·899757	9·884196	10.115804	10.100243	10.216047	33
28	9·784118	9·899660	9·884457	10.115543	10.100340	10.215886	32
29	9·784282	9·899564	9·884719	10.115281	10.100436	10.215718	31
30	9·784447	9·899467	9·884980	10.115020	10.100533	10.215553	30
		Sine		Tangent		Secant	Minutes

52 Degrees.

37 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.784447	9.899467	9.884980	10.115020	10.100533	10.215553	30
31	9.784612	9.899370	9.885242	10.114758	10.100630	10.215388	29
32	9.784776	9.899273	9.885503	10.114497	10.100727	10.215224	28
33	9.784944	9.899170	9.885765	10.114235	10.100824	10.215059	27
34	9.785105	9.899078	9.886026	10.113974	10.100922	10.214895	26
35	9.785269	9.898981	9.886288	10.113712	10.101019	10.214731	25
36	9.785433	9.898884	9.886549	10.113451	10.101116	10.214567	24
37	9.785597	9.898787	9.886810	10.113190	10.101213	10.214403	23
38	9.785761	9.898689	9.887072	10.112928	10.101311	10.214239	22
39	9.785925	9.898592	9.887333	10.112667	10.101408	10.214075	21
40	9.786089	9.898494	9.887594	10.112406	10.101506	10.213911	20
41	9.786252	9.898397	9.887855	10.112145	10.101603	10.213748	19
42	9.786416	9.898299	9 888116	10.111884	10.101701	10.213584	18
43	9.786579	9.898202	9.888377	10.111623	10.101798	10.213421	17
44	9.786742	9.898104	9.888639	10.111361	10.101896	10.213258	16
45	9.786906	9.898000	9.888900	10.111100	10.101994	10.213094	15
46	9.787069	9.897908	9.889160	10.110840	10.102092	10.212931	14
47	9.787232	9.897810	9.889421	10.110579	10.102190	10.212768	13
48	9.787395	9.897712	9.889682	10.110318	10.102288	10.212605	12
49	9.787557	9.897614	9.889943	10.110057	10.102386	10.212443	11
50	9.787720	9.897516	9.890204	10.109796	10.102484	10.212280	10
51	9.787883	9.897418	9.890465	10.109535	10.102582	10.212117	9
52	9.788045	9.897320	9.890725	10.109275	10.102680	10.211955	8
53	9.788208	9.897222	9.890986	10.109014	10.102778	10.211792	7
54	9.788370	9.897123	9.891247	10.108753	10.102877	10.211630	6
55	9.788532	9.897025	9.891507	10.108493	10.102975	10.211468	5
56	9.788694	9.896926	9.891768	10.108232	10.103074	10.211306	4
57	9.788856	9.896828	9.892028	10.107972	10.103172	10.211144	3
58	9.789018	9.896729	9.892289	10.107711	10.103271	10.210982	2
59	9.789180	9.896631	9.892549	10.107451	10.103369	10.210820	1
60	9.789342	9.896532	9.892810	10.107190	10.103468	10.210658	0
		Sine		Tangent		Secant	Minutes

52 Degrees.

38 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.789342	9.896532	9.892810	10.107190	10.103468	10.210658	60
1	9.789504	9.896433	9.893070	10.106930	10.103567	10.210496	59
2	9.789665	9.896335	9.893331	10.106669	10.103665	10.210335	58
3	9.789827	9.896236	9.893591	10.106409	10.103764	10.210173	57
4	9.789988	9.896137	9.893851	10.106149	10.103863	10.210012	56
5	9.790149	9.896038	9.894111	10.105889	10.103962	10.209851	55
6	9.790310	9.895939	9.894371	10.105629	10.104061	10.209690	54
7	9.790471	9.895840	9.894632	10.105368	10.104160	10.209529	53
8	9.790632	9.895741	9.894892	10.105108	10.104259	10.209368	52
9	9.790793	9.895641	9.895152	10.104848	10.104359	10.209207	51
10	9.790954	9.895542	9.895412	10.104588	10.104458	10.209046	50
11	9.791115	9.895443	9.895672	10.104328	10.104557	10.208885	49
12	9.791275	9.895343	9.895932	10.104068	10.104657	10.208725	48
13	9.791436	9.895244	9.896192	10.103808	10.104756	10.208564	47
14	9.791596	9.895144	9.896452	10.103548	10.104856	10.208404	46
15	9.791757	9.895045	9.896712	10.103288	10.104955	10.208243	45
16	9.791917	9.894945	9.896971	10.103029	10.105055	10.208083	44
17	9.792077	9.894846	9.897231	10.102769	10.105154	10.207923	43
18	9.792237	9.894746	9.897491	10.102509	10.105254	10.207763	42
19	9.792397	9.894646	9.897751	10.102249	10.105354	10.207603	41
20	9.792557	9.894546	9.898010	10.101990	10.105454	10.207443	40
21	9.792716	9.894446	9.898270	10.101730	10.105554	10.207284	39
22	9.792876	9.894346	9.898530	10.101470	10.105654	10.207124	38
23	9.793035	9.894246	9.898789	10.101211	10.105754	10.206965	37
24	9.793195	9.894146	9.899049	10.100951	10.105854	10.206805	36
25	9.793354	9.894046	9.899308	10.100692	10.105954	10.206646	35
26	9.793513	9.893946	9.899568	10.100432	10.106054	10.206487	34
27	9.793673	9.893846	9.899827	10.100173	10.106154	10.206327	33
28	9.793832	9.893745	9.900086	10.099914	10.106255	10.206168	32
29	9.793991	9.893645	9.900346	10.099654	10.106355	10.206009	31
30	9.794150	9.893544	9.900605	10.099395	10.106456	10.205850	30
		Sine		Tangent		Secant	Minutes

51 Degrees.

38 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.794150	9.893544	9.900605	10.099395	10.106456	10.205850	30
31	9.794308	9.893444	9.900864	10.099136	10.106556	10.205692	29
32	9.794467	9.893343	9.901124	10.098876	10.106657	10.205533	28
33	9.794626	9.893243	9.901383	10.098617	10.106757	10.205374	27
34	9.794784	9.893142	9.901642	10.098358	10.106858	10.205216	26
35	9.794942	9.893041	9.901901	10.098099	10.106959	10.205058	25
36	9.795101	9.892940	9.902160	10.097840	10.107060	10.204899	24
37	9.795259	9.892839	9.902419	10.097581	10.107161	10.204741	23
38	9.795417	9.892738	9.902679	10.097321	10.107262	10.204583	22
39	9.795575	9.892637	9.902938	10.097062	10.107363	10.204425	21
40	9.795733	9.892536	9.903197	10.096803	10.107464	10.204267	20
41	9.795891	9.892435	9.903455	10.096545	10.107565	10.204109	19
42	9.796049	9.892334	9.903714	10.096286	10.107666	10.203951	18
43	9.796206	9.892233	9.903973	10.096027	10.107767	10.203794	17
44	9.796364	9.892132	9.904232	10.095768	10.107868	10.203636	16
45	9.796521	9.892030	9.904491	10.095509	10.107970	10.203479	15
46	9.796679	9.891929	9.904750	10.095250	10.108071	10.203321	14
47	9.796836	9.891827	9.905008	10.094992	10.108173	10.203164	13
48	9.796993	9.891726	9.905267	10.094733	10.108274	10.203007	12
49	9.797150	9.891624	9.905526	10.094474	10.108376	10.202850	11
50	9.797307	9.891523	9.905784	10.094216	10.108477	10.202693	10
51	9.797464	9.891421	9.906043	10.093957	10.108579	10.202536	9
52	9.797621	9.891319	9.906302	10.093698	10.108681	10.202379	8
53	9.797777	9.891217	9.906560	10.093440	10.108783	10.202223	7
54	9.797934	9.891115	9.906819	10.093181	10.108885	10.202066	6
55	9.798091	9.891013	9.907077	10.092923	10.108987	10.201909	5
56	9.798247	9.890911	9.907336	10.092664	10.109089	10.201753	4
57	9.798403	9.890809	9.907594	10.092406	10.109191	10.201597	3
58	9.798560	9.890707	9.907852	10.092148	10.109293	10.201440	2
59	9.798716	9.890605	9.908111	10.091889	10.109395	10.201284	1
60	9.798872	9.890503	9.908369	10.091631	10.109497	10.201128	0
		Sine		Tangent		Secant	Minutes

51 Degrees.

39 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.798872	9.890503	9.908369	10.091631	10.109497	10.201128	60
1	9.799028	9.890400	9.908627	10.091373	10.109600	10.200972	59
2	9.799184	9.890298	9.908886	10.091114	10.109702	10.200816	58
3	9.799339	9.890195	9.909144	10.090856	10.109805	10.200661	57
4	9.799495	9.890093	9.909402	10.090598	10.109907	10.200505	56
5	9.799551	9.889990	9.909660	10.090340	10.110010	10.200349	55
6	9.799806	9.889888	9.909918	10.090082	10.110112	10.200194	54
7	9.799962	9.889785	9.910177	10.089823	10.110215	10.200038	53
8	9.800117	9.889682	9.910435	10.089565	10.110318	10.199883	52
9	9.800272	9.889579	9.910693	10.089307	10.110421	10.199728	51
10	9.800427	9.889470	9.910951	10.089049	10.110524	10.199573	50
11	9.800582	9.889374	9.911209	10.088791	10.110626	10.199418	49
12	9.800737	9.889271	9.911467	10.088533	10.110729	10.199263	48
13	9.800892	9.889167	9.911724	10.088276	10.110833	10.199108	47
14	9.801047	9.889064	9.911982	10.088018	10.110936	10.198953	46
15	9.801201	9.888961	9.912240	10.087760	10.111039	10.198799	45
16	9.801356	9.888858	9.912498	10.087502	10.111142	10.198644	44
17	9.801511	9.888755	9.912756	10.087244	10.111245	10.198489	43
18	9.801665	9.888651	9.913014	10.086986	10.111349	10.198335	42
19	9.801819	9.888548	9.913271	10.086729	10.111452	10.198181	41
20	9.801973	9.888444	9.913529	10.086471	10.111556	10.198027	40
21	9.802128	9.888341	9.913787	10.086213	10.111659	10.197872	39
22	9.802282	9.888237	9.914044	10.085956	10.111763	10.197718	38
23	9.802435	9.888133	9.914302	10.085698	10.111867	10.197565	37
24	9.802589	9.888030	9.914560	10.085440	10.111970	10.197411	36
25	9.802743	9.887926	9.914817	10.085183	10.112074	10.197257	35
26	9.802897	9.887822	9.915075	10.084925	10.112178	10.197103	34
27	9.803050	9.887718	9.915332	10.084668	10.112282	10.196950	33
28	9.803204	9.887614	9.915590	10.084410	10.112386	10.196796	32
29	9.803357	9.887510	9.915847	10.084153	10.112490	10.196643	31
30	9.803510	9.887406	9.916104	10.083896	10.112594	10.196490	30
		Sine		Tangent		Secant	Minntes

50 Degrees.

39 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.803510	9.887406	9.916104	10.083896	10.112594	10.196490	30
31	9.803664	9.887302	9.916362	10.083638	10.112698	10.196336	29
32	9.803817	9.887198	9.916619	10.083381	10.112802	10.196183	28
33	9.803970	9.887093	9.916876	10.083124	10.112907	10.196030	27
34	9.804123	9.886989	9.917134	10.082866	10.113011	10.195877	26
35	9.804276	9.886885	9.917391	10.082609	10.113115	10.195724	25
36	9.804428	9.886780	9.917648	10.082352	10.113220	10.195572	24
37	9.804581	9.886676	9.917905	10.082095	10.113324	10.195419	23
38	9.804734	9.886571	9.918163	10.081837	10.113429	10.195266	22
39	9.804886	9.886466	9.918420	10.081580	10.113534	10.195114	21
40	9.805038	9.886362	9.918677	10.081323	10.113638	10.194962	20
41	9.805191	9.886257	9.918934	10.081066	10.113743	10.194809	19
42	9.805343	9.886152	9.919191	10.080809	10.113848	10.194657	18
43	9.805495	9.886047	9.919448	10.080552	10.113953	10.194505	17
44	9.805647	9.885942	9.919705	10.080295	10.114058	10.194353	16
45	9.805799	9.885837	9.919962	10.080038	10.114163	10.194201	15
46	9.805951	9.885732	9.920219	10.079781	10.114268	10.194049	14
47	9.806103	9.885627	9.920476	10.079524	10.114373	10.193897	13
48	9.806254	9.885521	9.920733	10.079267	10.114479	10.193746	12
49	9.806406	9.885416	9.920990	10.079010	10.114584	10.193594	11
50	9.806557	9.885311	9.921247	10.078753	10.114689	10.193443	10
51	9.806709	9.885205	9.921503	10.078497	10.114795	10.193291	9
52	9.806860	9.885100	9.921760	10.078240	10.114900	10.193140	8
53	9.807011	9.884994	9.922017	10.077983	10.115006	10.192989	7
54	9.807163	9.884889	9.922274	10.077726	10.115111	10.192837	6
55	9.807314	9.884783	9.922530	10.077470	10.115217	10.192686	5
56	9.807465	9.884677	9.922787	10.077213	10.115323	10.192535	4
57	9.807615	9.884572	9.922044	10.076956	10.115428	10.192385	3
58	9.807766	9.884466	9.922300	10.076700	10.115534	10.192234	2
59	9.807917	9.884360	9.922557	10.076443	10.115640	10.192083	1
60	9.808067	9.884254	9.922813	10.076187	10.115746	10.191933	0
		Sine		Tangent		Secant	Minutes

50 Degrees.

40 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.808068	9.884254	9.923813	10.076187	10.115746	10.191932	60
1	9.808218	9.884148	9.924070	10.075930	10.115852	10.191782	59
2	9.808368	9.884042	9.924327	10.075673	10.115958	10.191632	58
3	9.808519	9.883936	9.924583	10.075417	10.116064	10.191481	57
4	9.808669	9.883829	9.924840	10.075160	10.116171	10.191331	56
5	9.808819	9.883723	9.925096	10.074904	10.116277	10.191181	55
6	9.808969	9.883617	9.925352	10.074648	10.116383	10.191031	54
7	9.809119	9.883510	9.925609	10.074391	10.116490	10.190881	53
8	9.809269	9.883404	9.925865	10.074135	10.116596	10.190731	52
9	9.809419	9.883297	9.926121	10.073879	10.116703	10.190581	51
10	9.809569	9.883191	9.926378	10.073622	10.116809	10.190431	50
11	9.809718	9.883084	9.926634	10.073366	10.116916	10.190282	49
12	9.809868	9.882977	9.926890	10.073110	10.117023	10.190132	48
13	9.810017	9.882871	9.927147	10.072853	10.117129	10.189983	47
14	9.810167	9.882764	9.927403	10.072597	10.117236	10.189833	46
15	9.810316	9.882657	9.927659	10.072341	10.117343	10.189684	45
16	9.810465	9.882550	9.927915	10.072085	10.117450	10.189535	44
17	9.810614	9.882443	9.928171	10.071829	10.117557	10.189386	43
18	9.810763	9.882336	9.928427	10.071573	10.117664	10.189237	42
19	9.810912	9.882228	9.928683	10.071317	10.117772	10.189088	41
20	9.811061	9.882121	9.928940	10.071060	10.117879	10.188939	40
21	9.811210	9.882014	9.929196	10.070804	10.117986	10.188790	39
22	9.811358	9.881907	9.929452	10.070548	10.118093	10.188642	38
23	9.811507	9.881799	9.929708	10.070292	10.118201	10.188493	37
24	9.811655	9.881692	9.929964	10.070036	10.118308	10.188345	36
25	9.811804	9.881584	9.930219	10.069781	10.118416	10.188196	35
26	9.811952	9.881477	9.930475	10.069525	10.118523	10.188048	34
27	9.812100	9.881369	9.930731	10.069269	10.118631	10.187900	33
28	9.812248	9.881261	9.930987	10.069013	10.118739	10.187752	32
29	9.812397	9.881153	9.931243	10.068757	10.118847	10.187603	31
30	9.812544	9.881045	9.931499	10.068501	10.118955	10.187456	30
		Sine		Tangent		Secant	Minntes

49 Degrees.

40 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.812544	9.881045	9.931499	10.068501	10.118955	10.187456	30
31	9.812692	9.880938	9.931755	10.068245	10.119062	10.187308	29
32	9.812840	9.880830	9.932010	10.067990	10.119170	10.187166	28
33	9.812988	9.880721	9.932266	10.067734	10.119279	10.187012	27
34	9.813135	9.880613	9.932522	10.067478	10.119387	10.186865	26
35	9.813283	9.880505	9.932778	10.067222	10.119495	10.186717	25
36	9.813430	9.880397	9.933033	10.066967	10.119603	10.186570	24
37	9.813578	9.880289	9.933289	10.066711	10.119711	10.186422	23
38	9.813725	9.880180	9.933545	10.066455	10.119820	10.186275	22
39	9.813872	9.880072	9.933800	10.066200	10.119928	10.186128	21
40	9.814019	9.879963	9.934056	10.065944	10.120037	10.185981	20
41	9.814166	9.879855	9.934311	10.065689	10.120145	10.185834	19
42	9.814313	9.879746	9.934567	10.065433	10.120254	10.185687	18
43	9.814460	9.879637	9.934823	10.065177	10.120363	10.185540	17
44	9.814607	9.879529	9.935078	10.064922	10.120471	10.185393	16
45	9.814753	9.879420	9.935333	10.064667	10.120580	10.185247	15
46	9.814900	9.879311	9.935589	10.064411	10.120689	10.185100	14
47	9.815046	9.879202	9.935844	10.064156	10.120798	10.184954	13
48	9.815193	9.879093	9.936100	10.063900	10.120907	10.184807	12
49	9.815339	9.878984	9.936355	10.063645	10.121016	10.184661	11
50	9.815485	9.878875	9.936610	10.063390	10.121125	10.184515	10
51	9.815631	9.878766	9.936866	10.063134	10.121234	10.184369	9
52	9.815778	9.878656	9.937121	10.062879	10.121344	10.184222	8
53	9.815923	9.878547	9.937376	10.062624	10.121453	10.184077	7
54	9.816069	9.878438	9.937632	10.062368	10.121562	10.183931	6
55	9.816215	9.878328	9.937887	10.062113	10.121672	10.183785	5
56	9.816361	9.878219	9.938142	10.061858	10.121781	10.183639	4
57	9.816507	9.878109	9.938397	10.061603	10.121891	10.183493	3
58	9.816652	9.877999	9.938653	10.061347	10.122001	10.183348	2
59	9.816797	9.877890	9.938908	10.061092	10.122110	10.183203	1
60	9.816943	9.877780	9.939163	10.060837	10.122220	10.183057	0
		Sine		Tangent		Secant	Minutes

49 Degrees.

41 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.816943	9.877780	9.939163	10.060837	10.122220	10.183057	60
1	9.817088	9.87767	9.939418	10.060582	10.122330	10.182912	59
2	9.817233	9.877560	9.939673	10.060327	10.122440	10.18276	58
3	9.817378	9.877450	9.939928	10.060072	10.122550	10.182622	57
4	9.817523	9.87734	9.940183	10.059817	10.122660	10.182477	56
5	9.817668	9.877230	9.940438	10.059562	10.122770	10.182332	55
6	9.817813	9.877120	9.940694	10.059306	10.122880	10.182187	54
7	9.817958	9.877010	9.940949	10.059051	10.122990	10.182042	53
8	9.818103	9.876899	9.941204	10.058796	10.123101	10.181897	52
9	9.818247	9.876789	9.941458	10.058 42	10.123211	10.181753	51
10	9.818392	9.876678	9.941713	10.058287	10.123322	10.181608	50
11	9.818536	9.876568	9.941968	10.058032	10.123432	10.181464	49
12	9.818681	9.876457	9.942223	10.057777	10.123543	10.181319	48
13	9.818825	9.876347	9.942478	10.057 22	10.123653	10.181175	47
14	9.818969	9.876236	9.942733	10.057267	10.123764	10.181031	46
15	9.819113	9.876125	9.942988	10.057012	10.123875	10.180887	45
16	9.819257	9.876014	9.943243	10.056757	10.123986	10.180743	44
17	9.819401	9.875904	9.943498	10.056502	10.124096	10.180599	43
18	9.819545	9.875793	9.943752	10.056248	10.124207	10.180455	42
19	9.819689	9.875682	9.944007	10.055993	10.124318	10.180311	41
20	9.819832	9.875571	9.944262	10.055738	10.124429	10.180168	40
21	9.819976	9.875459	9.944517	10.055483	10.124541	10.180024	39
22	9.820120	9.875348	9.944771	10.055229	10.124652	10.179880	38
23	9.820263	9.875237	9.945026	10.054974	10.124763	10.179737	37
24	9.820406	9.875126	9.945281	10.054719	10.124874	10.179594	36
25	9.820550	9.875014	9.945535	10.054465	10.124986	10.179450	35
26	9.820693	9.874903	9.945790	10.054210	10.125097	10.179307	34
27	9.820836	9.874791	9.946045	10.053955	10.125209	10.179104	33
28	9.820979	9.874679	9.946299	10.053701	10.125321	10.179021	32
29	9.821122	9.874568	9.946554	10.053446	10.125432	10.178878	31
30	9.821265	9.874456	9.946808	10.053192	10.125544	10.178735	30
		Sine		Tangent		Secant	Minutes

48 Degrees.

41 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.821265	9.874456	9.946808	10.053192	10.125544	10.178735	30
31	9.821407	9.874344	9.947063	10.052937	10.125656	10.178593	29
32	9.821550	9.874232	9.947317	10.052683	10.125768	10.178450	28
33	9.821693	9.874120	9.947572	10.052428	10.125880	10.178307	27
34	9.821835	9.874008	9.947826	10.052174	10.125992	10.178165	26
35	9.821977	9.873896	9.948081	10.051919	10.126104	10.178023	25
36	9.822120	9.873784	9.948335	10.051665	10.126216	10.177880	24
37	9.822262	9.873672	9.948590	10.051410	10.126328	10.177738	23
38	9.822404	9.873560	9.948844	10.051156	10.126440	10.177596	22
39	9.822546	9.873448	9.949099	10.050901	10.126552	10.177454	21
40	9.822688	9.873335	9.949353	10.050647	10.126665	10.177312	20
41	9.822830	9.873223	9.949607	10.050393	10.126777	10.177170	19
42	9.822972	9.873110	9.949862	10.050138	10.126890	10.177028	18
43	9.823114	9.872998	9.950116	10.049884	10.127002	10.176886	17
44	9.823255	9.872885	9.950370	10.049630	10.127115	10.176745	16
45	9.823397	9.872772	9.950625	10.049375	10.127228	10.176603	15
46	9.823539	9.872659	9.950879	10.049121	10.127341	10.176461	14
47	9.823680	9.872547	9.951133	10.048867	10.127453	10.176320	13
48	9.823821	9.872434	9.951388	10.048612	10.127566	10.176179	12
49	9.823963	9.872321	9.951642	10.048358	10.127679	10.176037	11
50	9.824104	9.872208	9.951890	10.048104	10.127792	10.175896	10
51	9.824245	9.872094	9.952150	10.047850	10.127906	10.175755	9
52	9.824386	9.871981	9.952404	10.047596	10.128019	10.175014	8
53	9.824527	9.871868	9.952659	10.047341	10.128132	10.175473	7
54	9.824668	9.871755	9.952913	10.047087	10.128245	10.175332	6
55	9.824808	9.871641	9.953167	10.046833	10.128359	10.175192	5
56	9.824949	9.871528	9.953421	10.046579	10.128472	10.175051	4
57	9.825090	9.871414	9.953675	10.046325	10.128586	10.174910	3
58	9.825230	9.871301	9.953929	10.046071	10.128699	10.174770	2
59	9.825370	9.871187	9.954183	10.045817	10.128813	10.174630	1
60	9.825511	9.871075	9.954437	10.045563	10.128927	10.174489	0
		Sine		Tangent		Secant	Minutes

48 Degrees.

42 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.825511	9.871073	9.954437	10.045563	10.128927	10.174489	60
1	9.825651	9.870960	9.954691	10.045309	10.129040	10.174349	59
2	9.825791	9.870846	9.954945	10.045055	10.129154	10.174209	58
3	9.825931	9.870732	9.955199	10.044801	10.129268	10.174069	57
4	9.826071	9.870618	9.955453	10.044547	10.129382	10.173929	56
5	9.826211	9.870504	9.955707	10.044293	10.129496	10.173789	55
6	9.826351	9.870390	9.955961	10.044039	10.129610	10.173649	54
7	9.826491	9.870276	9.956215	10.043785	10.129724	10.173509	53
8	9.826631	9.870161	9.956469	10.043531	10.129839	10.173369	52
9	9.826770	9.870047	9.956723	10.043277	10.129953	10.173230	51
10	9.826910	9.869933	9.956977	10.043023	10.130067	10.173090	50
11	9.827049	9.869818	9.957231	10.042769	10.130182	10.172951	49
12	9.827189	9.869704	9.957485	10.042515	10.130296	10.172811	48
13	9.827328	9.869589	9.957739	10.042261	10.130411	10.172672	47
14	9.827467	9.869474	9.957993	10.042007	10.130526	10.172533	46
15	9.827606	9.869360	9.958246	10.041754	10.130640	10.172394	45
16	9.827745	9.869245	9.958500	10.041500	10.130755	10.172255	44
17	9.827884	9.869130	9.958754	10.041246	10.130870	10.172116	43
18	9.828023	9.869015	9.959008	10.040992	10.130985	10.171977	42
19	9.828162	9.868900	9.959262	10.040738	10.131100	10.171838	41
20	9.828301	9.868785	9.959515	10.040485	10.130215	10.171699	40
21	9.828439	9.868670	9.959769	10.040231	10.131330	10.171561	39
22	9.828578	9.868555	9.960023	10.039977	10.131445	10.171422	38
23	9.828716	9.868440	9.960277	10.039723	10.131560	10.171284	37
24	9.828855	9.868324	9.960530	10.039470	10.131676	10.171145	36
25	9.828993	9.868209	9.960784	10.039216	10.131791	10.171007	35
26	9.829131	9.868093	9.961038	10.038962	10.131907	10.170869	34
27	9.829269	9.867978	9.961291	10.038709	10.132022	10.170731	33
28	9.829407	9.867862	9.961545	10.038455	10.132138	10.170593	32
29	9.829545	9.867747	9.961799	10.038201	10.132253	10.170455	31
30	9.829683	9.867631	9.962052	10.037948	10.132369	10.170317	30
		Sine		Tangent		Secant	Minutes

47 Degrees.

42 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.829683	9.867631	9.962052	10.037948	10.132369	10.170317	30
31	9.829821	9.867515	9.962306	10.037694	10.132485	10.170179	29
32	9.829959	9.867399	9.962560	10.037440	10.132601	10.170041	28
33	9.830097	9.867283	9.962813	10.037187	10.132717	10.169903	27
34	9.830234	9.867167	9.963067	10.036933	10.132833	10.169766	26
35	9.830372	9.867051	9.963320	10.036680	10.132949	10.169628	25
36	9.830509	9.866935	9.963574	10.036426	10.133065	10.169491	24
37	9.830646	9.866819	9.963827	10.036173	10.133181	10.169354	23
38	9.830784	9.866703	9.964081	10.035919	10.133297	10.169216	22
39	9.830921	9.866586	9.964335	10.035665	10.133414	10.169079	21
40	9.831058	9.866470	9.964588	10.035412	10.133530	10.168942	20
41	9.831195	9.866353	9.964842	10.035158	10.133647	10.168805	19
42	9.831332	9.866237	9.965095	10.034905	10.133763	10.168668	18
43	9.831469	9.866120	9.965349	10.034651	10.133880	10.168531	17
44	9.831606	9.866004	9.965602	10.034398	10.133996	10.168394	16
45	9.831742	9.865887	9.965855	10.034145	10.134113	10.168258	15
46	9.831879	9.865770	9.966109	10.033891	10.134230	10.168121	14
47	9.832015	9.865653	9.966362	10.033638	10.134347	10.167985	13
48	9.832152	9.865536	9.966616	10.033384	10.134464	10.167848	12
49	9.832288	9.865419	9.966869	10.033131	10.134581	10.167712	11
50	9.832425	9.865302	9.967122	10.032878	10.134698	10.167575	10
51	9.832561	9.865185	9.967376	10.032624	10.134815	10.167439	9
52	9.832697	9.865068	9.967630	10.032370	10.134932	10.167303	8
53	9.832833	9.864950	9.967883	10.032117	10.135050	10.167167	7
54	9.832969	9.864833	9.968136	10.031864	10.135167	10.167031	6
55	9.833105	9.864716	9.968389	10.031611	10.135284	10.166895	5
56	9.833241	9.864598	9.968643	10.031357	10.135402	10.166759	4
57	9.833377	9.864481	9.968896	10.031104	10.135519	10.166623	3
58	9.833512	9.864363	9.969149	10.030851	10.135637	10.166488	2
59	9.833648	9.864245	9.969403	10.030597	10.135755	10.166352	1
60	9.833783	9.864127	9.969656	10.030344	10.135873	10.166217	0
		Sine		Tangent		Secant	Minutes

47 Degrees.

43 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.833783	9.864127	9.969656	10.030344	10.135873	10.166217	60
1	9.833919	9.864010	9.969909	10.030091	10.135990	10.166081	59
2	9.834054	9.863892	9.970162	10.029838	10.136108	10.165946	58
3	9.834189	9.863774	9.970416	10.029584	10.136226	10.165811	57
4	9.834325	9.863656	9.970669	10.029331	10.136344	10.165675	56
5	9.834460	9.863538	9.970922	10.029078	10.136462	10.165540	55
6	9.834595	9.863419	9.971175	10.028825	10.136581	10.165405	54
7	9.834730	9.863301	9.971429	10.028571	10.136699	10.165270	53
8	9.834865	9.863183	9.971682	10.028318	10.136817	10.165135	52
9	9.834999	9.863064	9.971935	10.028065	10.136936	10.165001	51
10	9.835134	9.862946	9.972188	10.027812	10.137054	10.164866	50
11	9.835269	9.862827	9.972441	10.027559	10.137173	10.164731	49
12	9.835403	9.862709	9.972695	10.027305	10.137291	10.164597	48
13	9.835538	9.862590	9.972948	10.027052	10.137410	10.164462	47
14	9.835672	9.862471	9.973201	10.026799	10.137529	10.164328	46
15	9.835807	9.862353	9.973454	10.026546	10.137647	10.164193	45
16	9.835941	9.862234	9.973707	10.026293	10.137766	10.164059	44
17	9.836075	9.862115	9.973960	10.026040	10.137885	10.163925	43
18	9.836209	9.861996	9.974213	10.025787	10.13800	10.163791	42
19	9.836343	9.861877	9.974466	10.025534	10.138123	10.163657	41
20	9.836477	9.86175	9.974719	10.025281	10.138242	10.163523	40
21	9.836611	9.861638	9.974973	10.025027	10.138362	10.163389	39
22	9.836745	9.861519	9.975226	10.024774	10.138481	10.163255	38
23	9.836878	9.861400	9.975479	10.024521	10.138600	10.163122	37
24	9.837012	9.861280	9.975732	10.024268	10.138720	10.162988	36
25	9.837146	9.861161	9.975985	10.024015	10.138839	10.162854	35
26	9.837279	9.861041	9.976238	10.023762	10.138959	10.162721	34
27	9.837413	9.860921	9.976491	10.023509	10.139079	10.162587	33
28	9.837546	9.860802	9.976744	10.023256	10.139198	10.162454	32
29	9.837679	9.860682	9.976997	10.023003	10.139318	10.162321	31
30	9.837812	9.860562	9.977250	10.022750	10.139438	10.162188	30
		Sine		Tangent		Secant	Minutes

46 Degrees.

43 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.837812	9.860562	9.977250	10.022750	10.139438	10.162188	30
31	9.837945	9.860442	9.977503	10.022497	10.139558	10.162055	29
32	9.838078	9.860322	9.977756	10.022244	10.139678	10.161922	28
33	9.838211	9.860202	9.978009	10.021991	10.139798	10.161789	27
34	9.838344	9.860082	9.978262	10.021738	10.139918	10.161656	26
35	9.838477	9.859962	9.978515	10.021485	10.140038	10.161523	25
36	9.838610	9.859842	9.978768	10.021232	10.140158	10.161390	24
37	9.838742	9.859721	9.979021	10.020979	10.140279	10.161258	23
38	9.838875	9.859601	9.979274	10.020726	10.140399	10.161125	22
39	9.839007	9.859480	9.979527	10.020473	10.140520	10.160993	21
40	9.839140	9.859360	9.979780	10.020220	10.140640	10.160860	20
41	9.839272	9.859239	9.980033	10.019967	10.140761	10.160728	19
42	9.839404	9.859119	9.980286	10.019714	10.140881	10.160596	18
43	9.839536	9.858998	9.980538	10.019462	10.141002	10.160464	17
44	9.839668	9.858877	9.980791	10.019209	10.141123	10.160332	16
45	9.839800	9.858756	9.981044	10.018956	10.141244	10.160200	15
46	9.839932	9.858635	9.981297	10.018703	10.141365	10.160068	14
47	9.840064	9.858514	9.981550	10.018450	10.141486	10.159936	13
48	9.840196	9.858393	9.981803	10.018197	10.141607	10.159804	12
49	9.840328	9.858272	9.982056	10.017944	10.141728	10.159672	11
50	9.840459	9.858150	9.982309	10.017691	10.141850	10.159541	10
51	9.840591	9.858029	9.982562	10.017438	10.141971	10.159409	9
52	9.840722	9.857908	9.982814	10.017186	10.142092	10.159278	8
53	9.840854	9.857786	9.983067	10.016933	10.142214	10.159146	7
54	9.840985	9.857665	9.983320	10.016680	10.142335	10.159015	6
55	9.841116	9.857543	9.983573	10.016427	10.142457	10.158884	5
56	9.841247	9.857421	9.983826	10.016174	10.142579	10.158753	4
57	9.841378	9.857300	9.984079	10.015921	10.142700	10.158622	3
58	9.841509	9.857178	9.984331	10.015669	10.142822	10.158491	2
59	9.841640	9.857056	9.984584	10.015416	10.142944	10.158360	1
60	9.841771	9.856934	9.984837	[illegible]	10.143066	10.158229	0
		Sine		[illegible]		Secant	Minutes

46 [illegible]

44 Degrees.

Minutes	Sine		Tangent		Secant		
0	9.841771	9.856934	9.984837	10.015163	10.143066	10.158229	60
1	9.841902	9.856812	9.985090	10.014910	10.143188	10.158098	59
2	9.842033	9.856690	9.985343	10.014657	10.143310	10.157967	58
3	9.842163	9.856568	9.985596	10.014404	10.143432	10.157837	57
4	9.842294	9.856445	9.985848	10.014152	10.143555	10.157706	56
5	9.842424	9.856323	9.986101	10.013899	10.143677	10.157576	55
6	9.842555	9.856201	9.986354	10.013646	10.143799	10.157445	54
7	9.842685	9.856078	9.986607	10.013393	10.143922	10.157315	53
8	9.842815	9.855956	9.986860	10.013140	10.144044	10.157185	52
9	9.842946	9.855833	9.987112	10.012888	10.144167	10.157054	51
10	9.843076	9.855711	9.987365	10.012635	10.144289	10.156924	50
11	9.843206	9.855588	9.987618	10.012382	10.144412	10.156794	49
12	9.843336	9.855465	9.987871	10.012129	10.144535	10.156664	48
13	9.843465	9.855342	9.988123	10.011877	10.144658	10.156535	47
14	9.843595	9.855219	9.983376	10.011624	10.144781	10.156405	46
15	9.843725	9.855096	9.988629	10.011371	10.144904	10.156275	45
16	9.843855	9.854973	9.988882	10.011118	10.145027	10.156145	44
17	9.843984	9.854850	9.989134	10.010866	10.145150	10.156016	43
18	9.844114	9.854727	9.989387	10.010613	10.145273	10.155886	42
19	9.844243	9.854603	9.989640	10.010360	10.145397	10.155757	41
20	9.844372	9.854480	9.989893	10.010107	10.145520	10.155628	40
21	9.844502	9.854356	9.990145	10.009855	10.145644	10.155498	39
22	9.844631	9.854233	9.990398	10.009602	10.145767	10.155369	38
23	9.844760	9.854109	9.990651	10.009349	10.145891	10.155240	37
24	9.844889	9.853986	9.990903	10.009097	10.146014	10.155111	36
25	9.845018	9.853862	9.991156	10.008844	10.146138	10.154982	35
26	9.845147	9.853738	9.991409	10.008591	10.146202	10.154853	34
27	9.845276	9.853614	9.991662	10.008338	10.146386	10.154724	33
28	9.845404	9.853490	9.991914	10.008086	10.146510	10.154596	32
29	9.845533	9.853366	9.992167	10.007833	10.146634	10.154467	31
30	9.845602	9.853242	[illegible]	10.007580	10.146758	10.154338	30
		Sine		angent		Secant	Minutes

4[illegible]rees,

44 Degrees.

Minutes	Sine		Tangent		Secant		
30	9.845662	9.853242	9.992420	10.007580	10.146758	10.154338	30
31	9.845790	9.853118	9.992672	10.007328	10.146882	10.154210	29
32	9.845919	9.852994	9.992925	10.007075	10.147006	10.154081	28
33	9.846047	9.852869	9.993178	10.006822	10.147131	10.153953	27
34	9.846175	9.852745	9.993430	10.006570	10.147255	10.153825	26
35	9.846304	9.852620	9.993683	10.006317	10.147380	10.153696	25
36	9.846432	9.852496	9.993936	10.006064	10.147504	10.153568	24
37	9.846560	9.852371	9.994189	10.005811	10.147629	10.153440	23
38	9.846688	9.852247	9.994441	10.005559	10.147753	10.153312	22
39	9.846816	9.852122	9.994694	10.005306	10.147878	10.153184	21
40	9.846944	9.851997	9.994947	10.005053	10.148003	10.153056	20
41	9.847071	9.851872	9.995199	10.004801	10.148128	10.152929	19
42	9.847199	9.851747	9.995452	10.004548	10.148253	10.152801	18
43	9.847327	9.851622	9.995705	10.004295	10.148378	10.152673	17
44	9.847454	9.851497	9.995957	10.004043	10.148503	10.152546	16
45	9.847582	9.851372	9.996210	10.003790	10.148628	10.152418	15
46	9.847709	9.851246	9.996463	10.003537	10.148754	10.152291	14
47	9.847837	9.851121	9.996715	10.003285	10.148879	10.152163	13
48	9.847964	9.850996	9.996968	10.003032	10.149004	10.152036	12
49	9.848091	9.850870	9.997221	10.002779	10.149130	10.151909	11
50	9.848218	9.850745	9.997473	10.002527	10.149255	10.151782	10
51	9.848345	9.850619	9.997726	10.002274	10.149381	10.151655	9
52	9.848472	9.850493	9.997979	10.002021	10.149507	10.151528	8
53	9.848599	9.850367	9.998231	10.001769	10.149633	10.151401	7
54	9.848726	9.850242	9.998484	10.001516	10.149758	10.151274	6
55	9.848852	9.850116	9.998737	10.001263	10.149884	10.151148	5
56	9.848979	9.849990	9.998989	10.001011	10.150010	10.151021	4
57	9.849106	9.849864	9.999242	10.000758	10.150136	10.150894	3
58	9.849232	9.849737	9.999495	10.000505	10.150263	10.150768	2
59	9.849359	9.849611	9.999747	10.000253	10.150389	10.150641	1
60	9.849485	9.849485	10.000000	10.000000	10.150515	10.150515	0
		Sine		Tangent		Secant	Minutes

45 Degrees.

7720

A TABLE of Angles, which every Rumb (or Point of the *Compaſs*) maketh with the *Meridian*.

North	*South*	*Point*	*D.*	*M.*	*North*	*South*
		¼	2	49		
		½	5	37		
		¾	8	26		
N by E.	S by E	1	11	15	N by W	S by W
		1 ¼	14	4		
		1 ½	16	52		
		1 ¾	19	41		
N N E	S S E	2	22	30	N N W	S S W
		2 ¼	25	19		
		2 ½	28	7		
		2 ¾	30	56		
NE by N	SE by S	3	33	45	NW by N	SW by S
		3 ¼	36	34		
		3 ½	39	22		
		3 ¾	42	11		
No. Eaſt	Sou. Eaſt	4	45	00	No. Weſt	Sou. Weſt
		4 ¼	47	49		
		4 ½	50	37		
		4 ¾	53	26		
NE by E	SE by E	5	56	15	NW by W	SW by W
		5 ¼	59	4		
		5 ½	61	52		
		5 ¾	64	41		
E N E	E S E	6	67	30	W N W	W S W.
		6 ¼	70	19		
		6 ½	73	7		
		6 ¾	75	56		
E by N	E by S	7	78	45	W by N	W by S
		7 ¼	81	34		
		7 ½	84	22		
		7 ¾	87	11		
Eaſt	Eaſt	8	90	00	Weſt	Weſt

FINIS.

9°
61–52
28 . 08

D759
A876a